SSP 50191

NASA/ESA Bilateral Safety and Product Assurance Requirements

International Space Station Program

Baseline

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National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center
Houston, Texas

REVISION AND HISTORY PAGE

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-	Initial Release	05-05-99

PREFACE

The NASA/ESA Bilateral Safety and Product Assurance Requirements document is a joint National Aeronautics and Space Administration (NASA) and European Space Agency (ESA) document which describes all safety and product assurance requirements applicable to the ESA.

The contents of this document are derived from JESA 30000, section 9, Revision A, November 1993: NASA/STA Space Station Freedom Joint Program Definition and Requirements Document (JPDRD); Safety and Product Assurance Requirements, and SSP 30000, section 9, Revision F, September 1993; Space Station Program Definition and Requirements, section 9: Product Assurance Requirements.

The NASA/ESA Bilateral Safety and Product Assurance Requirements document is controlled after approval signatures, by the NASA Space Station Program Director and the ESA Program Manager. Both NASA and ESA herein mutually agree that the execution of this document is necessary for the effective and safe integration of the ESA Elements into the International Space Station.

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/s/ F. A. Longhurst 15 March 1999
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INTERNATIONAL SPACE STATION PROGRAM
NASA/ESA BILATERAL SAFETY AND PRODUCT ASSURANCE REQUIREMENTS DOCUMENT

CONCURRENCE

May, 1997

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INTERNATIONAL SPACE STATION PROGRAM
NASA/ESA BILATERAL SAFETY AND PRODUCT ASSURANCE REQUIREMENTS DOCUMENT

LIST OF CHANGES

May, 1997

All changes to paragraphs, tables, and figures in this document are shown below:

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)

TABLE(S)

FIGURE(S)

APPENDIX(ES)

ADDENDA

PARAGRAPH TABLE OF CONTENTS PAGE

1.0 INTRODUCTION

The ESA PA/Safety requirements are contained in the ESA project system requirements (e.g. COL-RQ-ESA-001, MS-RQ-ESA-004) and its associated ESA standards specification documents.

1.1 PURPOSE

This document establishes the joint hardware and software safety and product assurance (reliability, maintainability, and Quality Assurance) implementation requirements between NASA and ESA for the design, development, production, test, and operation of ESA vehicles, during the ISS program.

1.2 SCOPE

These safety and product assurance requirements are applicable to all flight equipment, Orbital Support Equipment (OSE), Flight Support Equipment (FSE), and certain Ground Support Equipment (GSE) (as specified herein) and related software supplied for the ESA projects.

1.3 MANAGEMENT APPROACH

The ESA Product Assurance implementation and Safety approach is covered by MS-RQ-ESA-004 and associated ESA standards specification documents.

Management of safety and product assurance shall include the following:

1.3.A Defining the major hardware and software safety and product assurance tasks and assuring that they are performed as integral parts of all phases of the program

1.3.B Evaluating the safety, reliability, maintainability, and quality of hardware, software, and operations through analyses, tests, reviews, and assessments

1.3.C Providing timely status reporting through periodic project reviews and as a part of overall project status reports

1.3.D Ensuring compatible safety and product assurance requirements for manufacturing, test, launch, and ground operations. For ESA, a safety and product assurance management plan shall be prepared by the project contractor. Safety and product assurance management shall have direct unimpeded access to the management level having full project responsibility.

1.4 RELATION TO OTHER PROGRAM REQUIREMENTS

1.4.1 PROGRAM REQUIREMENTS

The safety and product assurance analytical and verification requirements set forth in this document shall take precedence in cases of conflict with requirements contained in sub-tier documents. The safety and product assurance design requirements are contained in, for instance, in the applicable ESA segment specifications (e.g. SSP 41160, Segment Specification for the European Space Agency). The ESA requirements of MS-RQ-ESA-004 shall be the basis of the safety and product assurance program for the ESA projects and its interface to the ISS.

1.4.2 GSE HARDWARE AND SOFTWARE

NASA provided Safety and Mission Assurance (S&MA) analyses for GSE hardware and software used by ISS, but procured by other programs, need not be performed again when evaluation approved by the Product Groups and International Partners Project Office proposing the use of the GSE shows each analysis to be adequate to meet the intent of the applicable ISS analytical requirements document. All Critical Items and accepted risk hazards identified in these analyses must be baselined by the ISS.

1.5 MOTIVATION

Not Applicable.

1.6 INDEPENDENT EVALUATIONS FOR NASA OR THE INTERNATIONAL PARTNERS

ESA reserves the right to appoint independent representatives to assist in Safety and Product Assurance evaluation activities. These representatives will provide technical support to the applicable parent organization and determine effectiveness of and recommend improvements for Safety and Product Assurance activities.

NASA participation in such activities at ESA contractors will be subject to ESA agreement, on a case by case basis.

1.7 DATA EXCHANGE AGREEMENTS

All S&PA exchange data between NASA and ESA as agreed through the requirement of this document shall be identified in SSP 50127, NASA/ESA Data Exchange Agreement.

1.8 SAFETY AND PRODUCT ASSURANCE DATABASE

Safety and product assurance databases shall be established. The data transfer format will be defined in the SSP 50127, NASA/ESA Data Exchange Agreement.

1.9 MILESTONE REVIEWS

Safety and product assurance activities shall include supporting design reviews, and NASA and ESA design and readiness reviews. Participation in milestone reviews shall assure that safety and product assurance requirements are adequately considered.

1.10 DELEGATION OF AUTHORITY

This document will be revised as required. Revisions will be made according to the agreements in the NASA/ESA Joint Management Plan, SSP 50019.

2.0 APPLICABLE AND REFERENCE DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents of the date, issue, and revision shown form part of this document to the extent specified herein.

For NASA generated documents, "Current Issue" is shown in place of the specific date and issue when the document is under Program Office Space Station Control Board (SSCB) control

For ESA generated documents, "Current Issue" is shown in place of the specific date and issue, when the document is under ESA Configuration Control.

ESA DOCUMENT

"XXX"-RQ-ESA-001 (Current Issue)	"XXX" System Requirements Document by the applicable (Current Issue) ESA project "XXX"(e.g. XXX = COL for APM/COF project)
MS-RQ-ESA-004 (Current Issue)	Product Assurance Requirements
MS-ESA-HB-13 (Current Issue)	Manned Space Flight Human Factors Engineering Handbook
MS-RQ-ESA-028 (Current Issue)	CPRACA Requirements for Columbus
MS-ESA-PR-004 (Current Issue)	Safety Review Process for the Manned Spaceflight Projects

2.2 REFERENCE DOCUMENTS

The following documents referred to herein may be utilized by ESA for information and guidance in implementing the requirements of this document.

ISS DOCUMENTS

SSP 30309	Safety Analysis and Risk Assessment Requirements (Current Issue) Document Reference Paragraph 6.2.3
SSP 30459	Space Station Interface Development Process Requirements
SSP 30599	Safety Review Process Document Reference Paragraph 6.1.4.2
SSP 41160	Segment Specification for the European Space Agency Attached Pressurized Module

SSP 41170	Configuration Management Requirements
SSP 41173	Space Station Quality Assurance Requirements. (Current Issue) Reference Paragraph 4.0
SSP 50005	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T)
SSP 50013	Information Systems Plan
SSP 50127	Bilateral Data Exchange Agreement
TSS 30696, Volume 2	Assembly and Maintenance Implementation Definition Document (AMIDD) Volume II: Maintenance Reference Paragraph 3.1.1.2
NASA-STD-3000	Man-Systems Integration Standards Reference Paragraph 6.2.6
NHB 1700.1 (V1-A)	Basic Safety Manual Reference Paragraph 6.3
NHB 1700.1 (V3)	System Safety
NHB 1700.1 (V9)	NASA Safety Manual-Fire Protection Reference Paragraph 6.3

2.3 EQUIVALENCY OF PROCESS DOCUMENTS

The following matrix delineates the correspondence between ESA documents and documents called out in SSP 30000, Section 9. The matrix shows the status of the determination of the Meet/Exceed equivalency of the documents

(See Matrix Provided per JESA 30000) (matrix - page 1)

TABLE 1 TRACEABILITY MATRIX

NASA	Rev.	ESA Tier 3	Rev.	Equivalency	Date
SSP 30223 Problem Reporting and Corrective Action System Requirements for the Space Station Program	D 29July 92	Columbus Problem Reporting and Corrective Action Requirements COL-RQ-ESA-028	Issue 4 30-Jan-92	YES Usage per paragraph 4.7.6	Aug-92
SSP 30233 Space Station Requirements for Materials and Processes	C 26 Sep 91	PSS-01-70	Issue 3 Oct 87	YES Per BB003255	Aug-92
SSP 30234 Instructions for Preparation of Failure Modes and Effects (FMEA) and Critical Items List (CIL) for Space Station	A 30 Jun 88 with SSCBD BB000658B	Document per ESA/NASA agreement			Dec-97
SSP 30309 Hazard Analysis and Risk Assessment Requirements	B 23 Oct 91 with SSCBD BB003134	Columbus System Requirements Document (SRD) COL-RQ-ESA-001 ESA/Columbus PA/Safety Requirements COL-RQ-ESA-004 System Safety requirements for ESA Space Systems Associated Equipment PSS-01-40	Issue 2 12 Aug 92 Issue 1, Rev E Dec 91 Issue 2 Sept 88	Yes with 3 exceptions: 1)SSP 30309 Para. 3.1.5 will be modified 2)Para 5.2 and Para 5.4.3 are pending approval of SSP 30599 in change Request BB003229B *NOTE 1*	Aug-92
SSP 30312 Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan for Space Station Program	C 11 Sep 91	PSS-01-60	Issue 2 Nov 88	Yes *NOTE 2*	Aug 92
SSP 30423 Space Station Allowed Electrical, Electronic and Electromechanical Parts List	C 30 Jul 91	Columbus Preferred Parts List	Issue 3B	Yes *NOTE 2*	Aug-92
SSP 30595 Space Station Freedom Payload Safety Review Process	TBD	TBD	TBD	TBD	
SSP 30599 Safety Review Process for Space Station Program	per BB003229B	ESA/Columbus Safety Review Process for Space Station Related Flight Configurations COL-PR-ESA-004	Issue 1 9 Apr 92	TBD	

NASA	Rev.	ESA Tier 3	Rev.	Equivalency	Date
SSP TBD Critical Item Control Plan	TBD	TBD	TBD	TBD	
MIL-STD 105		-	-	Applicable to ESA	
MIL-STD 414		-	-	Applicable to ESA	
MIL-STD 970	1-Oct-87	PSS-01-60	Issue 2 Nov 88	Yes *NOTE 2*	Aug-92
MIL-STD 975	Jan-92	ESA/SCC QPL		Yes *NOTE 2*	Aug-92
NSTS 1700.7B	13 Jan 89	-	-	Applicable by Section 3, JPDRD	
NASA STD 3000 (Vol. 4)	Nov 86	COL-RQ-ESA-013	Issue 2, Rev. C 8-Nov.-91	Yes, refer to JESA 30000 Section 3	
NHB 5300.4(3A-1)	1 Dec 76	PSS-01-708	Issue 1 Mar 85	TBD	Aug. 92
NHB 5300.4(3F)	1 Jun 72	TBD		TBD	
NHB 5300.4 (3G)	1 Apr 85	PSS-01-708	Issue 1 Mar 85	TBD	Aug. 92
NHB 5300.4(3H)	1 May 84	PSS-01-726	Issue 1 Dec 90	TBD	Aug. 92
NHB 5300.4(3I)	1 May 84	PSS-01-710 and PSS-01-728	Issue 1 Oct 85 Issue 1 Feb 83	TBD	Aug. 92
NHB 5300.4(3J)	1 Apr 85	ESA Approved Industry Standards		TBD	Aug 92
NHB 5300.4(3K)	7 Jan 86	PSS-01-710 and PSS-01-728	Issue 1 Oct 85	TBD	Aug 92
KMI 1710.1	21 Apr 88	-	-	Applicable to ESA for KSC Operations	

***NOTE 1:** **ESA/NASA agree that the cross reference matrix for SSP 30309 as contained in the minutes of the 8/3-7/92 Meets/Exceeds coordination meeting and as enhanced by DSS-3 constitutes adequate rationale for meets or exceeds agreement. The minutes with the enhanced matrix will be kept on file by the SSPO Configuration Management Office within the BB003239 records.**

*** NOTE 2:** **Equivalency rationale/traceability per minutes of NASA/ESA Safety and Product Assurance Technical Interchange Meeting of August 3-7, 1992**

(matrix - page 2)

TABLE 2 TRACEABILITY MATRIX

SSP 50038, Rev. B, Computer-Based Control System Safety Requirements, “Meets or Exceeds” Table, ESA APM Computer Based Control Systems, as agreed in June 1997.

The following is a listing of the “meets or exceeds” traceability of ESA Software Requirements to SSP 50038.

SSP 50038	CSRD	STATUS	SPE-1211 366
3.1	4.5.1, 4.5.1.3	OK	
3.1.1.1	7.2.1.4	ESA action: Review other requirements	5.16.3.2.7
3.1.1.2	4.5.3.2, 7.8.5	Intent met	3.2.8
3.1.1.3	7.2.5.1 & RQ-14, 5.7.6,	OK	
3.1.1.4	4.4.2.3	OK	5.16.3.2.18
3.1.1.5	7.2.3.5, 7.2.3.13	OK	5.16.2.3.4, 5.16.2.2.6
3.1.1.6	4.7.8.1, 4.5.19.1, 4.5.19.2	OK	5.14.3.1
3.1.1.7	7.2.5	OK	
3.1.1.8	7.2.5 (FDIR) 6.2.2.8	Intent met	
3.1.1.9 3.1.1.10	RQ-023 & STD 1213 800, para. 4.1, and and para. 6.1	OK	
3.1.1.11	6.2.2.8, 7.2.3.6	OK	
3.1.1.12	Not applicable		
3.1.1.13	7.2.3.5, 7.2.5	OK	5.16.2.2.6, 5.16.2.3.4
3.1.2.1	4.5.5.3	OK	
3.1.2.1.1 3.1.2.1.2 3.1.2.1.3	4.5.5.3	OK	5.16.3.2.18
3.1.2.1.4	6.1.3, 4.5.2.2, 4.6.1, 4.4.3	Intent met	
3.1.2.1.5	4.4.3	OK	

SSP 50038	CSRD	STATUS	SPE-1211 366
3.1.2.1.6	SSP 41160B, 3.2.1.1.1.9, 3.2.1.1.1.15	OK	
3.1.3.1.1		7.2.3.5, 7.2.3.13 OK	
3.1.3.1.2	4.5.3.12, 4.5.5.3	OK	
3.1.3.1.3	4.5.3.12, 4.5.5.3	OK	
3.1.3.1.4	4.4.2.1, 7.2.4 SSP 41160B, 3.3.6.1.5	4.4.2.1, 7.2.4.2	Intent met.
3.1.3.1.5	4.4.2.2, 4.4.2.3, 4.5.4.2, 4.5.5.3		
3.1.3.1.6	4.4.2.2, 4.4.2.3, 4.5.4.2, 4.5.5.3	Intent met.	
3.1.3.1.7	Not applicable		5.16.3.2.18
3.1.3.1.8	7.2.4.2, 7.2.3.25	OK	
3.1.3.1.9	7.2.4.2, 7.2.3.25	OK	
3.1.3.1.10	4.6.2, 4.4.2.1	OK	
3.1.3.2.1	7.2.4.2, SSP 41160B, 3.3.3.1.5		Intent met.
3.1.3.2.2	4.6.2	OK	
3.1.3.2.3	4.5.3.12, 4.5.5.3	Intent met.	
3.1.3.2.4	4.5.5.3	Intent met.	
3.1.3.2.5	4.4.2.2, 4.4.2.3, 4.5.5.2, 4.5.5.3	Intent met	
3.1.3.2.6	Not applicable		
3.1.3.2.7	4.6.2	OK	
3.1.3.2.8	7.2.4.2, 7.2.3.25	OK	
3.1.3.2.9	SSP 41160B, 3.2.1.1.1.15	OK	

MEET/EXCEED TRACEABILITY OF SSP 30223, REV. D WITH COL-RQ-028

The following is a TRACEABILITY MATRIX between SSP 30223 Revision D of July/92, (PRACA System Requirements for the Space Station Program) versus COL-RQ-ESA-028, Issue 2 of 30/01/92 (CPRACA Requirements for Columbus Program).

The Revision D of SSP 30223 introduces SSP 30524 the PRACA Data System (PDS) Requirements. Reference to it are made throughout the document for data requirements and electronic reporting. As specified in SSP 30223, Section 3.2, these requirements need to be modified by separate agreement with ESA, since ESA will use its own system.

All SSP 30223 requirements are met or exceeded by COL-RQ-ESA-028:

SSP 30223 Section:	**COL-RQ-ESA-028 Section**:
1.0 Purpose	1.0
1.1 Scope	3 (para 1,2)
2.0 Documents	just title
2.1 Applicable Documents	2
2.2 Reference Documents	N/A
3.0 Applicability 4	
3.1 Non-Conformance Reporting	3 (para. 3), and PSS-01-20, Appendix B
3.2 Reportable Problems	5
3.2.1 Detected during	5 (para. 2)
3.2.2 H/W and S/W involved	5 (para. 3)
3.2.3 Problem categories	5 (para. 2)
4.0 Organizational Responsibilities	N/A
4.1 SSF Program Office	N/A
4.2 Work Package Centers	N/A
4.3 Design Centers	6.2
5.0 Problem Reporting Requirements	3 (para. 3), 2.2 and 7
5.1 System Level Problem Reporting	N/A. Note (1)
6.0 Problem Disposition Processing	8
6.1 Problem Resolution/Deferral	just title
6.1.2 Determination of Cause	8
6.1.3 Corrective Action/Explanations	8. Note(2)
6.1.4 Problem Closure	8
6.2 Deferral Processing	N/A. note(3)
FMEA and CIL's	8(last para)

Note (1): The definition of ESA/NASA system level problems(I/F and common H/W-S/W problems), as well as the reporting requirements, is outside the scope of COL-RQ-ESA-028, and it has to be negotiated and agreed at JPDRD level. COL-RQ-ESA-028 are the

ESA requirements towards the Prime Contractor. The interface with ISS is performed by ESA.

Note (2): As above, time reporting requirements are to be agreed at JPDRD level, and they are outside the COL-RQ-ESA-028 scope.

Note (3): The deferral case is not considered in COL-RQ-ESA-028. No problem resolution will be deferred by ESA. Nevertheless, the “Meet or Exceed” is not affected.

3.0 RELIABILITY AND MAINTAINABILITY

3.1 MANAGEMENT

Reliability and maintainability activities shall be planned and developed to be an integral part of the ESA project design, development, test and evaluation, and operational activities.

Scheduled status control will be used to provide visibility and assist in reporting, controlling and assessment of the reliability and maintainability effort. Objectives will be to plan and establish the reliability and maintainability effort; to define the major reliability and maintainability tasks and their place as an integral part of the design and development process; to assure the effective implementation of reliability and maintainability requirements; to evaluate system reliability and maintainability characteristics through a program of analysis, review, and test/demonstration; and to conduct trades between reliability, maintainability, and related disciplines to establish optimum availability.

3.1.1 ORGANIZATION

Organization of the reliability and maintainability efforts shall assure effective planning, management, implementation, and performance of reliability and maintainability activities. While the accomplishment of all reliability and maintainability tasks may not be the responsibility of the same organizational element, management of the reliability and maintainability efforts shall assure that all tasks are effectively accomplished. Reliability and maintainability management shall have direct access and shall report regularly to program/project management.

3.1.2 PLANNING

Reliability planning shall assure adequate implementation control of reliability requirements as specified in ESA project, Product Assurance/Safety and System Requirements documents.

3.1.2.1 RELIABILITY PLANS

The reliability planning for the ESA Manned Space Flight Program and its interface to the ISS shall implement the requirements of ESA project System Requirements Document, and MS-RQ-ESA-004 (PA/S Requirements) and the jointly agreed interface requirements between the ESA project and ISS.

3.1.2.2 MAINTAINABILITY PLANS

The maintainability planning for the ESA projects and its interface to the ISS shall implement the requirements of COL-RQ-ESA-001 (SRD) and MS-RQ-ESA-004 (PA/S Requirements), and the jointly agreed interface requirements between ESA projects and ISS.

3.1.3 AUDITS AND SURVEYS

The reliability and maintainability efforts shall include contractor internal audits and vendor/supplier surveys to evaluate the progress and effectiveness of reliability and maintainability activities and to determine the need for adjustments or changes. Audits and surveys shall be conducted at intervals as defined by the reliability and maintainability plans.

3.1.4 SUPPLIER RELIABILITY AND MAINTAINABILITY CONTROL

The reliability and maintainability efforts shall assure that hardware/software obtained from any source, including off-the-shelf (OTS), meets the reliability and maintainability requirements of the overall system. Management controls shall be provided to assure the adequacy of the implementation of the requirements. The level of requirements imposed on shall consistent with those specified in MS-RQ-ESA-004.

3.1.5 NASA OR INTERNATIONAL PARTNER FURNISHED EQUIPMENT (GFE/IGFE) RELIABILITY AND MAINTAINABILITY

Reliability and maintainability data needed for GFE/AFE shall be identified by the contractor or supplying Agency and shall be supplied by the supplying Agency. When examination of these data or testing indicates that the equipment is not consistent with the reliability and/or maintainability requirements of the ESA projects , the supplying Agency shall be formally and promptly notified.

3.2 RELIABILITY AND MAINTAINABILITY ENGINEERING

Reliability and maintainability engineering tasks shall be accomplished, to the extent specified, for all flight equipment, flight support equipment, orbital support equipment, ground support equipment, and NASA or ESA furnished equipment which could cause personnel injuries or damage to the facility or which interfaces with flight hardware. All maintainability activities shall be consistent with the ISS requirements are specified in the ESA segment specification , SSP 41160. Maintainability engineering efforts shall support maintenance planning efforts as appropriate.

3.2.1 RELIABILITY AND MAINTAINABILITY DESIGN CRITERIA

The reliability and maintainability efforts shall include the establishment of reliability and maintainability design criteria and assure that the criteria are incorporated into each design. The reliability and maintainability efforts shall include a systematic approach for reviewing and concurring in design and procurement specifications and in design changes to assure that all design items reflect proper and complete reliability and maintainability design criteria and that the specifications contain applicable reliability and maintainability requirements.

3.2.2 RELIABILITY AND MAINTAINABILITY ANALYSES/TRADE STUDIES

3.2.2.1 RELIABILITY ANALYSES/TRADE STUDIES

The reliability effort shall include participation in design trades and assessments utilizing reliability modeling and numerical predictions as appropriate. Reliability criteria, such as failure modes and effects, frequency of failures, and operating life, shall be evaluated as part of engineering and operational trade studies.

3.2.2.2 MAINTAINABILITY ANALYSES/TRADE STUDIES

The maintainability effort shall include participation in design trades and assessments utilizing maintainability modeling and numerical predictions as appropriate. Maintainability criteria, such as mean-time-to-repair, restorability considerations and maintenance crew time shall be evaluated as part of engineering and operational trade studies.

3.2.3 HARDWARE FAILURE MODES AND EFFECTS ANALYSES (FMEA)s

A system for preparing, maintaining, and controlling FMEAs shall be established in accordance with MS-RQ-ESA-004.

3.2.3.1 FLIGHT HARDWARE FMECAs

FMECAs program shall be implemented for the ESA projects. The FMECA shall be conducted for each mission phase. ESA shall provide NASA assistance for performance of the FMECA and CIL integration. ESA shall provide for independent oversight of the FMECA to assure that the ESA projects FMECA meets the ISS Program needs.

3.2.3.2 GSE FMECAs

GSE FMECAs shall be prepared in accordance with MS-RQ-ESA-004.

3.2.3.3 PAYLOAD FMECAs

This is not a subject of this document as ESA payloads are not the responsibility of the ESA Manned Space Flight Program Department.

3.2.4 CRITICALITY CATEGORIES

Criticality Categories applicable to the ISS elements are defined as follows and are provided here for information only:

3.2.4.1 Criticality Categories for the ESA projects are defined in the respective program's applicable System Requirements Document (SRD). ESA shall provide failure modes and effects data to allow NASA to perform integrated failure modes and effects analyses which address the interface with the ESA projects in due time prior to planned ISS milestone reviews. In order to allow ESA to perform complete failure mode and effects addressing the interface with the ESA projects' FMEA data shall be provided by NASA, in due time prior to planned ESA projects milestone reviews.

3.2.4.1.1 Criticality Category 1 is a single failure point that could result in the loss of a Space Station Program Element (SSPE) or loss of flight or ground personnel.

3.2.4.1.2 Criticality Category 1R are redundant hardware items all of which if failed, could result in loss of an SSPE or loss of flight or ground personnel.

3.2.4.1.3 Criticality Category 1S is a single failure point of the system component designed to provide safety or protection capability against a potentially hazardous condition or event or a single failure point in a safety or hazard monitoring system that causes the system to fail to detect, or operate when needed during the existence of a hazardous condition that could lead to loss of flight or ground personnel or an SSPE (e.g., fire suppression, medical hardware, etc.)

3.2.4.1.4 Criticality Category 1SR are redundant system components designed to provide safety or protection capability against a potentially hazardous condition or event, all of which if failed could cause the system to fail to detect, or operate when needed during the existence of a hazardous condition that could lead to loss of flight or ground personnel or an SSPE; or, redundant components within a safety or hazard monitoring system, all of which if failed could

cause the system to fail to detect, or operate when needed during the existence of a hazardous condition that could lead to loss of flight or ground personnel or SSPE.

3.2.4.1.5 Criticality Category 1P is a single failure point which is protected by a safety device, the proper function of which would prevent the loss of an SSPE or loss of flight or ground personnel.

3.2.4.1.6 Criticality Category 2 is a single failure point that could result in loss of critical mission support capability. Note: For Ground Support Equipment (GSE), this is damage to ISS equipment.

3.2.4.1.7 Criticality Category 2R are redundant hardware items all of which if failed, could result in loss of critical mission support capability.

3.2.4.1.8 Criticality Category 3 includes all others.

3.2.4.2 GSE Criticality Categories are as follows:

3.2.4.2.1 GSE Criticality Category 1 is a single failure which could result in loss of life or flight hardware.

3.2.4.2.2 GSE Criticality Category 1R are two redundant hardware items, which if both failed, could result in loss of life or flight hardware.

3.2.4.2.3 GSE Criticality Category 1S is a single failure in a safety or hazard monitoring system that could cause the system to fail to detect, combat, or operate when needed during the existence of a hazardous condition and could result in loss of life or flight hardware.

3.2.4.2.4 GSE Criticality Category 2 is a single failure which could result in damage of a flight system.

3.2.4.2.5 GSE Criticality Category 3 includes all others.

3.2.5 CRITICAL ITEM CONTROL

3.2.5.1 CRITICAL ITEMS LIST (CIL) PREPARATION

Based on results of the FMECAs, a CIL, which includes retention rationale, shall be prepared. The CIL shall consist of Criticality 1 and 2 failure points and redundant items in life-essential applications which do not meet the program failure tolerance requirements. In addition, the CIL will contain all items in which any of the following occur:

3.2.5.1.A Item(s) which cannot be checked out during pre-launch or in orbit before being required to operate

3.2.5.1.B Item(s) whose loss cannot be detected by the flight or ground crew during any mission phase

3.2.5.1.C Item(s) which cannot be restored on orbit.

3.2.6 RELIABILITY AND MAINTAINABILITY DATA

Component failure rate data shall be compiled for all flight hardware in accordance with MS-RQ-ESA-004. Maintainability data shall be compiled in accordance with MS-RQ-ESA-004.

3.2.7 LIMITED-LIFE ITEMS

The life-limiting criteria and characteristics for limited-life items shall be established, and limited-life items shall be identified. The status of limited-life items shall be recorded in order to enable refurbishment and replacement of these items and projection of their remaining life. Limited-life hardware identification shall be in accordance with MS-RQ-ESA-004 and applicable ESA project SRD (System Requirements Document).

3.2.8 MILESTONE REVIEWS

Reliability and maintainability activities shall include support to major ESA projects milestone reviews. Participation in milestone reviews shall assure that reliability and maintainability requirements are adequately considered.

3.2.9 CONFIGURATION CONTROL BOARDS AND PANELS

Reliability and maintainability assurance personnel shall support configuration control boards and panels through evaluation, tracking, and follow-up of engineering changes. Each engineering change package shall contain a reliability and maintainability assessment of the impact of the proposed change.

3.2.10 PROBLEM REPORTING SYSTEM

Reliability and maintainability activities shall support the ESA projects problem reporting system. This support shall include the establishment and verification of corrective action/recurrence control for design related problems.

3.2.11 VERIFICATION ASSURANCE

Reliability and maintainability shall assure that an effective verification program is established and implemented. Reliability and maintainability assurance activities shall include participation in such verification processes as development, certification, acceptance, check-out, and maintainability verification. The reliability and maintainability verification shall be performed as required in MS-RQ-ESA-004 and applicable ESA project SRD (Systems Requirements Document)

3.3 ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL (EEE) AND MECHANICAL PARTS CONTROL

The ESA project system for controlling EEE parts and mechanical parts/materials/process is based on the ESA requirements of MS-ESA-RQ-004.

4.0 QUALITY ASSURANCE

4.1 MANAGEMENT AND PLANNING

4.1.1 PLANNING

Quality Assurance activities shall be planned and developed to be an integral part of design, development, test and evaluation production, and operational activities and refurbishment/overhaul. Scheduled status reporting will be used to provide visibility and assist in controlling the Quality Assurance effort. Objectives will be to plan and establish the Quality Assurance effort; to define the major Quality Assurance tasks and their place as an integral part of the design and development process; and to assure the effective implementation of Quality Assurance requirements. Quality Assurance program planning shall address all program phases and shall provide a comprehensive management approach to preventing, detecting, documenting, and resolving actual or potential nonconformances.

4.1.2 ORGANIZATION

organizations and personnel responsible for implementing and performing Quality Assurance functions shall have well defined responsibilities, authority, and organizational freedom to develop and implement Quality Assurance disciplines and controls. The quality management shall have direct unimpeded access to the management level having full responsibility for the program/project work.

4.1.3 QUALITY PROGRAM PLAN

The quality assurance planning for the ESA projects and its interface to the space station shall implement the requirements of MS-RQ-ESA-004 (PA/S Requirements), and the jointly agreed interface requirements between ESA projects and space station. The launch site quality planning shall be addressed in the Launch Site Safety Plan (TBD-#).

4.1.4 PLANNING FOR ON-ORBIT ACTIVITIES

A systematic means of evaluating on-orbit activities including assembly, planned and unplanned maintenance, and hardware upgrades shall be developed. This planning shall identify required inspections, inspection tools, frequency of inspections, calibrations, and associated training. The results of the planning shall be provided as inputs to the on-orbit maintenance operations and logistics plans. The evaluation shall be accomplished and documented at Orbital Replaceable Unit (ORU), maintenance, and assembly levels. Failure causes, failure modes, and criticality identified on the FMEA shall be considered.

4.1.5 MANAGEMENT ASSESSMENT DATA

The quality organization shall provide a quality progress and status report to their respective program management office and/or applicable contract agency as defined by the contract documents.

4.1.6 TRAINING

Training of quality assurance personnel shall follow the requirements of MS-RQ-ESA-004.

4.1.7 INTERNAL QUALITY PROGRAM AUDITS AND SURVEYS

In implementing the requirements of MS-RQ-ESA-004, Quality Assurance shall conduct audits or surveys of task performance, procedures, and operations which implement the quality program. Assessments shall be conducted periodically as appropriate with program maturity. Each audit or survey shall include an examination of operations and documentation, evaluation of actual operations as compared with established requirements, documentation of discrepancies and deficiencies, and recommendations for corrective action, as appropriate. A corrective action plan will be prepared by the audited organization. This plan shall address measures to be taken to correct discrepancies/deficiencies noted during the survey/audit. Follow-up activities will occur and will include reviews to ensure that measures required by the corrective action plan are being properly implemented.

The results of audits and surveys shall be documented in a report to management. Management action shall be taken to ensure correction of the reported deficiencies. Follow-up reviews shall be made to ensure that required corrections have been implemented. Records of the contractor's audits and surveys shall be available for review by the applicable procurement agency or its delegated representative.

4.1.8 MILESTONE REVIEWS

Quality Assurance activities shall support project milestones such as design, acceptance, and readiness reviews. Participation in reviews shall assure that quality requirements are adequately considered in decisions which affect hardware design, configuration controls, initiation of subsystem and systems testing, shipment, and readiness for flight. Quality Assurance data presented will contain sufficient detail to allow management to determine whether or not it is acceptable to proceed with the next program activity phase.

4.2 DESIGN AND DEVELOPMENT CONTROLS

4.2.1 TECHNICAL DOCUMENTS

Quality Assurance shall participate in reviews of technical documents and changes thereto prior to document release. Technical documents include, but are not limited to, specifications, engineering drawings, engineering change orders, program plans, implementing procedures, work instructions, deviations/waivers, and documentation. Designs produced by automated systems shall have an equivalent level of control.

4.2.1.A

Quality Assurance shall verify that a documentation system that assures the inclusion of quality characteristics and design criteria in specifications, procedures, drawings, fabrication and inspection planning, and test documents is established and implemented.

4.2.1.B

Quality Assurance shall assure that the drawing system and other specifications identify hardware characteristics requiring verification with particular emphasis on critical characteristics. This identification shall be used in developing quality inspection and test verification planning and procedures.

4.2.2 QUALITY SUPPORT TO DESIGN REVIEWS

Quality Assurance shall participate in design reviews to ensure that designs permit and facilitate the quality considerations of repeatability, inspectability, and refurbishability/maintainability and that other related quality considerations are defined. These reviews shall reflect the adequacy of implementation of quality assurance requirements and criteria as defined in the MS-RQ-ESA-004.

4.2.3 CHANGE CONTROL VERIFICATION

In conjunction with COL-RQ-ESA-001 and its requirement implementation, engineering changes shall be reviewed by Quality Assurance to determine the quality impact. ESA shall be notified of any proposed changes in fabrication, materials, methods, or processes which may affect the quality of the space station provided interface to the ESA projects. Change incorporation shall be verified in accordance with specified effectivity with special attention to changes involving interface relationships.

4.2.4 PRODUCT/PROCESS DEVELOPMENT AND VALIDATION

Quality Assurance shall participate in product and process development activities to ensure that fabrication quality requirements are defined in concert with product requirements. Quality shall assure criteria for material, and process controls are developed consistent with these requirements.

Commensurate with these activities, Quality Assurance shall develop methods and planning for verification of these requirements with particular emphasis on early identification of critical characteristics.

4.3 IDENTIFICATION AND DATA RETRIEVAL

4.3.1 GENERAL

A documented identification and data retrieval system shall be developed, implemented, and maintained. Each article and material shall be identified by a unique part or type number, and the method shall be specified on engineering drawings and specifications. All disciplines shall use identification numbers related to the engineering design. Criticality, design complexity, application, performance characteristics, manufacturing, processing or environmental conditions, and limited-life sensitivity shall be used to determine the level of control applied through identification and data retrieval requirements. An identification and data retrieval system shall be provided for parts and materials installed or consumed in the ESA projects. This system shall provide visibility to the related manufacturer's lot or batch number and/or date code for parts and materials. An identification and retrieval system shall be developed for part and material locations as follows:

4.3.1.A

Each article and material shall be identified by a unique part or type number. One or more of the following detailed identification methods shall be used as applicable:

4.3.1.A.1

Date codes indicating date of manufacture to identify articles or materials made by a continuous and controlled process and those which are subject to variation of degradation with age.

4.3.1.A.2
Lot numbers to identify individual materials or articles produced in homogeneous groups.

4.3.1.A.3
Serial numbers to identify materials or articles for which unique data are to be maintained.

4.3.1.B
Other identification methods, such as paint dots, etc., must be approved by the procurement agency or a designated representative.

4.3.1.C
Methods of location of part or type numbers and detailed identification on articles shall be indicated in technical documents.

4.3.1.D
Controls shall be included to assure identification numbers are assigned in a consecutive manner.

4.3.1.E
Records shall indicate detailed identification and be organized so that records and the related article or material may be located and retrieved as necessary.

4.3.1.F
Requirements shall be established for EEE parts which will provide the capability of tracing backwards from fabricated hardware to the lot from which the part originated.

4.3.2 RETENTION OF RECORDS
Records shall be retained in a safe, accessible location for the period required in the contract requirements. Records shall not be destroyed unless authorized by ESA.

4.3.3 RECORD RETRIEVAL
Record systems shall ensure that records are identified and related to the applicable articles and materials. The system shall be organized so that these records and the related articles and materials may be rapidly located and retrieved.

4.4 PROCUREMENT

4.4.1 PROCUREMENT CONTROLS
The procuring agency is responsible for assuring that purchased articles, materials, and services conform to the requirements specified in this document and other program requirements. Control of procurements shall include identification of contract quality requirements, selection of qualified suppliers, verification of product quality and compliance with contractual requirements, and provisions for reporting and correcting nonconformances.

4.4.2 SELECTION OF CONTRACTOR PROCUREMENT SOURCES

The Quality Assurance organization shall participate in the selection of procurement sources based on one of the following:

4.4.2.A
The procurement source shall have a previous and continuing record of supplying quality articles, materials, or services of the type being procured.

4.4.2.B
A pre-award survey of the procurement source facility and quality system shall be conducted in accordance with documented procedures, developed by the procuring organization, to determine if the procurement source is capable of satisfying procurement quality requirements. The results of pre-award surveys shall be documented and maintained on file.

4.4.2.C
When articles or materials were fabricated specifically for contracts issued under other ESA contracts that have current acceptable surveys, a pre-award survey is not required.

4.4.3 PROCUREMENT DOCUMENTS
Procurement documents shall be written and processed in accordance with the following:

4.4.3.A
Prior to release, applicable procurement documents shall be approved by quality personnel to ensure inclusion of appropriate quality requirements and associated documentation.

4.4.3.B
Procurement documents shall require each procurement source and its sub-tier sources to comply with the applicable requirements of MS-RQ-ESA-004.

The quality system of suppliers of off-the-shelf items shall be reviewed and evaluated to establish the adequacy of their imposed quality system. Items such as historical information, previous quality performance, and compliance with standardized quality systems shall be factors during the course of the review.

4.4.3.C
Procurement documents shall contain the following specific requirements:

4.4.3.C.1
Changes. The procurement source shall be required to notify the procuring organization of any proposed changes in fabrication, materials, methods, or processes previously approved and shall obtain written approval from the procuring authority before making the change. When a proprietary item is procured, the procurement source shall be required to notify the procuring organization of changes in materials, fabrication methods, processes, or product operating characteristics prior to delivery.

4.4.3.C.2

Test Results. Records of test results shall be maintained and must be traceable to the procured articles. Purchased raw materials shall be accompanied with chemical and/or physical test results. Procedures shall provide for periodic suppliers of raw materials.

4.4.3.C.3
ESA Source Inspections. When ESA elects to perform source inspection, the ESA's rules and regulations shall be followed.

4.4.4 REVIEW OF PROCUREMENT DOCUMENTS
The process by which NASA ensures product quality shall be governed by its rules and regulations.

The process by which ESA ensures product quality shall be governed by its rules and regulations.

4.4.5 NASA QUALITY ASSURANCE PERSONNEL AT SOURCE
The process by which NASA ensures product quality at NASA contractors or suppliers facilities shall be governed by NASA rules and regulations.

In this context, ESA and its project contractors are neither contractor nor supplier to NASA.

4.4.6 RECEIVING INSPECTION
Quality Assurance shall develop, implement, and maintain a documented receiving inspection activity to ensure that procured articles comply with procurement document requirements, inspection and test data are accurate and acceptable, evidence of contractor and procuring/contracting agency source inspection has been provided as required, specified identification and data retrieval requirements have been met, time/cycle-sensitive articles are identified, expended and remaining time/cycle information is complete, chemical analyses and physical tests are performed, and receiving inspection results and status of articles are maintained. Procedures shall provide for planned laboratory analysis and testing to verify the validity of test reports received from suppliers.

4.4.7 PROCUREMENT SOURCE DATA
Inspections and test results commencing with receiving inspection shall be recorded to reflect, on a continuous basis, the qualitative and quantitative performance of individual sources and the quality histories of the supplied articles and materials. Data shall be maintained to establish trends of potential problems, and initiate action to resolve any negative trends.

4.4.8 AUDITS AND SURVEYS OF PROCUREMENT SOURCE OPERATIONS
The procuring organization shall schedule and conduct audits and surveys of procurement sources based upon the following:

4.4.8.A
Type of items being procured; e.g., criticality or complexity of article or material or special processes involved.

4.4.8.B

Procurement source quality history including known problems or difficulties

4.4.8.C
Remaining period of procurement source performance.

Audits and surveys shall evaluate the quality system, including implementing policies and procedures, and shall be performed in accordance with documented procedures and checklists which are based on program requirements. Audits and surveys results shall be documented and follow-up action shall be taken to ensure deficiencies have been corrected within the specified period of time.

Each procuring/contracting organization and major contractor may participate in a joint audit or survey program with other effected centers and contractors to minimize the number of audit and surveys performed at common procurement sources.

4.5 FABRICATION CONTROLS

4.5.1 FABRICATIONS OPERATIONS

The Quality Assurance Organization shall survey-control fabrication operations, including assembly and test, to ensure that critical characteristics of the design are identified and their conformance to engineering specifications is maintained in all articles produced. Critical characteristics shall be selected by quality, manufacturing, and engineering personnel and shall be derived from drawings, specifications, FMEAs, CIL, Hazard Analysis, etc. Critical characteristics shall be designated as inspection points that must be verified by Quality Assurance personnel. Identification of these characteristics, definition of methods, and sequence of operation shall be consistent with the criteria, methods, and plans developed during product development and reviewed at design reviews. Detailed fabrication and inspection planning shall be available for procuring/contracting organization review prior to fabrication and shall contain the following as a minimum:

4.5.1.A
Nomenclature and identification of the article to be fabricated

4.5.1.B
Drawings and specifications required

4.5.1.C
Tooling, jigs, fixtures, and other fabrication equipment to be utilized

4.5.1.D
Detailed instructions for fabrication and assembly of articles

4.5.1.E
Characteristics and tolerances to be obtained

4.5.1.F

Detailed procedures for controlling processes and cleaning, preservation, and packaging operations

4.5.1.G
Special conditions to be maintained such as environmental controls, specific cleanliness levels, an precautions to be observed

4.5.1.H
Workmanship standards if applicable

4.5.1.I
Specific inspections and/or test operations to be performed during fabrication to provide verification of design characteristics

4.5.1.J
Special handling equipment and protective devices [e.g. Electrostatic Discharge (ESD) Control]

4.5.1.K
Traceability to the individual performing the operation and to the inspection personnel verifying compliance

4.5.1.L
Traceability for the CIL where applicable

4.5.1.M
Configuration data, including parts lists, drawings, changes, specifications, and identification data, to ensure fabrication to the proper design requirements.

If quality designees (reference paragraph 4.5.8) are used, the operations to be performed by such personnel shall be strictly identified.

When the procurement agency has specified source inspection, the planning shall be coordinated with the procurement agency or its delegated representative for inclusion of mandatory inspection points.

4.5.2 ARTICLE AND MATERIAL CONTROLS
The following controls shall ensure that only conforming articles and materials are accepted and used:

4.5.2.A
Data shall be maintained for articles identified as having characteristics of quality degradation or drift with age and/or use. The date, time, or cycle from which useful life is calculated; the date, time, or cycle at which the useful life will be expended; and the incurred operating time or cycles shall be recorded.

4.5.2.B

Quality Assurance shall verify that requirements for articles and materials to be fabricated, processed, inspected, or tested in a temperature, humidity, ESD, or contamination controlled environment are properly implemented.

4.5.2.C
Quality Assurance shall verify, prior to initial use and at established intervals thereafter, the accuracy of production jigs, fixtures, tooling masters, templates, patterns, and other devices used for inspection.

4.5.3 CLEANLINESS/CONTAMINATION CONTROL
Quality Assurance shall assure that contaminant-sensitive items are cleaned and controlled in accordance with documented procedures to the levels specified in the applicable technical documents and are maintained to these cleanliness levels. These procedures shall cover hardware, equipment, personnel, and control of such areas as fabrication, assembly, inspection, test, and storage. Specific cleanliness levels to be maintained for systems, subsystems, and major components shall be indicated on drawings, specifications, or other documents controlling the manufacture and test of those items. Quality Assurance shall assure that clean-room disciplines and procedures are properly implemented and monitored to assure continuing compliance with requirements.

4.5.4 PROCESS CONTROLS
Quality Assurance shall implement controls for those processed where uniform, high quality cannot be assured by inspection of articles alone. These processes include, but are not limited to, metallurgical and chemical processes, soldering, welding, potting, bonding processes, plating and coating processes, and surface treating processes. These controls shall assure that special processes are performed by certified personnel; that facilities, equipment, materials, and procedures are adequate, maintained, and properly used; and that records are controlled. An up-to-date listing shall be maintained of all process control procedures and process specifications used in the fabrication, control, and inspection of the materials and articles. Contractor process specifications shall be available for review by the procurement agency or its delegated representative. The contractor shall also furnish similar information from the subcontractors upon request.

4.5.5 NONDESTRUCTIVE EVALUATION (NDE)
NDE methods shall be used, as required, and controlled to ensure quality hardware. NDE standards shall be used or prepared based on hardware configurations and geometry. Quantitative acceptance or rejection criteria shall be established for each NDE application. Personnel performing non-destructive evaluation processes shall be trained and certified.

4.5.6 WORKMANSHIP STANDARDS
Workmanship standards shall be employed throughout all phases of hardware manufacture to control the quality of the operation. These standards must comply with or be equivalent to standards acceptable to ESA.

Samples or visual aids required to verify acceptable workmanship shall be subject to review by the designated quality representative. Standards shall identify specific acceptance/rejection criteria.

4.5.7 CONTROL OF TEMPORARY INSTALLATIONS AND REMOVALS

Logs or other means shall ensure the management and control of articles or components that are temporarily installed or removed to facilitate manufacturing, testing, shipping, or handling of the Contract End Item (CEI). The control shall be initiated upon installation or removal of the first temporarily installed or removed item and shall be maintained through delivery and use of the equipment. Temporarily installed items shall be uniquely identified to prevent them from becoming a part of the final configuration.

4.5.8 INSPECTION PROCEDURES

Where inspection operations are complex and difficult to perform, Quality Assurance shall assure the preparation of specifically planned procedures to assure accuracy and validity of data and supplement the normal fabrication and inspection planning. These procedures shall be formally controlled and shall be based on current design information.

4.6 TEST CONTROLS

4.6.1 VERIFICATION

Quality Assurance shall monitor tests which verify that program, contract, drawing, and specification requirements as appropriate, have been met on all articles and materials procured and produced. Quality Assurance approval of such test results shall be provided to show that the quality required by the design is maintained in the articles produced. Quality Assurance shall review the test or verification plan to ensure inclusion of pertinent quality requirements.

4.6.2 TEST PROCEDURES

Approved test procedures shall be readily available to inspection and test personnel at the applicable location at the time of inspection or test. Quality Assurance shall assure that test procedures include the following information:

4.6.2.A
Nomenclature and identification of the test article or material

4.6.2.B
Characteristics and design criteria including values and tolerances for acceptance and rejection

4.6.2.C
Identification of characteristics and design criteria specified for verification

4.6.2.D
Detailed steps and operations to be taken in sequence including verifications to be made before proceeding

4.6.2.E
Identification of measuring or NDE equipment to be used specifying range and type

4.6.2.F

Details or instructions for operation of special data recording equipment

4.6.2.G
Layout of interconnection of test equipment and articles

4.6.2.H
Identification of hazardous situations or operations

4.6.2.I
Precautions to comply with established safety requirements, ensure safety of personnel, and to prevent damage or degradation of articles and measuring equipment

4.6.2.J
Environment and other conditions to be maintained

4.6.2.K
Identification of any reference drawings, specifications, workmanship standards and/or other reference documents required to enable full comprehension of test requirements

4.6.2.L
Constraints on inspection of testing

4.6.2.M
Special instructions for nonconformances, anomalous occurrences, or results

4.6.2.N
Details of sampling plans used

4.6.2.O
Details of NDEs

4.6.2.P
Identification of steps that involve critical items or requirements

4.6.2.Q
Configuration/revision level of hardware/software used during test

4.6.3 TEST PERFORMANCE
Quality Assurance shall assure that tests are performed in accordance with approved procedures and that any deviations to the test procedures are properly recorded and approved. Each test operation shall be traceable to the individual responsible for its accomplishment. Articles undergoing test shall not be adjusted, modified, repaired, reworked, or replaced except as authorized by properly approved documents. Quality Assurance test verification shall include the following:

4.6.3.A

Prior to testing, Quality Assurance shall verify that approved test procedures are available, that test equipment is calibrated and properly configured, that the facility is properly configured, that all manufacturing and lower level test operations are complete, and that the configuration of the article is correct and ready for test.

4.6.3.B
During testing, Quality Assurance shall verify that testing is performed in accordance with approved test procedures or that procedure deviations are recorded, that test data are accurately recorded, and that all nonconformances are documented.

4.6.3.C
Subsequent to testing, Quality Assurance shall verify that test results and data are complete and traceable to the test articles, that proper dispositions of articles have been made, that nonconformances are documented, that remedial action and recurrence control requirements are initiated and that integrity control of test articles is properly established and implemented.

4.6.3.D
Documentation shall include procedures for the development, verification and control of computer software/firmware used in conjunction with measurement and test equipment for acceptance of articles.

4.6.4 INSPECTION AND TEST RECORDS AND DATA

4.6.4.1 RECORDS
Records and data of all inspection and tests performed shall be prepared and maintained in sufficient detail to verify and evaluate the status of articles and materials.

4.6.4.2 END-ITEM ACCEPTANCE DATA PACKAGE (ADP)
An ADP shall be prepared and maintained for each end item.

4.6.4.3
End-Item Acceptance Review (AR). Quality Assurance shall participate in ARs to assure compliance with documentation requirements. The following information shall be available for review at the end-item AR:

4.6.4.3.A
A summary of test and checkout operations and results with discussion of anomalies encountered, failure history, remedial actions, and recurrence control.

4.6.4.3.B
The status of any open work, including open items from previous reviews, shortages, nonconformances, unincorporated engineering changes, etc., and constraints on further activities.

4.6.4.3.C
Identification of waivers/deviations and verification of approval

4.6.4.3.D
Identification of limited life components and their remaining life

4.6.4.3.E
A comparison of as-designed versus as-built configuration listings and rationale for any differences from approved baseline designs

4.6.4.3.F
The test procedure and test data for all end item acceptance tests including strip charts, deviations, and other data applicable to evaluate test records.

4.6.4.3.G
Completed deliverable end-item data package(s)

4.6.4.3.H
A Certificate of Acceptance (COA)

4.6.4.3.I
Records of all nonconformances occurring during manufacturing and test of end-item

4.6.4.3.J
Handling, shipping, storage, preservation, packing, and packaging instructions, including environmental constraints, identification of hazards, and maintenance requirements and user manuals.

In addition, all supporting documentation, which may be required to establish equipment acceptability, should be readily retrievable. This includes, but is not limited to, engineering-drawings, schematics, supplier ADPs, test specifications, fabrication and inspection test records, etc.

4.7 NONCONFORMING ARTICLES AND MATERIALS

4.7.1 NONCONFORMANCE CONTROL SYSTEM
Quality Assurance shall establish, implement, and maintain a documented closed-loop system for controlling nonconformances. This system shall include provisions for recording, analysis, remedial action, recurrence control, verification, and feedback of data on articles and materials which do not conform to drawings, specifications, or other requirements. Special emphasis shall be placed on tracking and resolving repetitive nonconformances. It shall be assured that subcontractors and suppliers implement a closed-loop system which complies with the requirements of this paragraph. The ESA requirements for the NCR system are provided in MS-RQ-ESA-004.

4.7.2 IDENTIFICATION OF NONCONFORMANCES
Nonconformances shall be documented in Non-Conformance Reports (NCR). Nonconformance recording shall commence with initial receipt of materials or articles and continue through all

subsequent phases of the program. Nonconforming articles or materials shall be identified, segregated to the extent practicable, and held for disposition.

4.7.3 NONCONFORMANCE EVALUATION
Appropriate analysis and examination of nonconforming articles, materials, or conditions shall be conducted to determine the cause or reason for the nonconformance and toe recommend further action. Nonconformances shall be classified into MINOR or MAJOR according to the requirements of MS-RQ-ESA-004.

4.7.4 NONCONFORMANCE DISPOSITIONS
Under his responsibility, the contractor may disposition MINOR nonconforming articles or materials as follows:

4.7.4.A RETURN TO SUPPLIER
When, on receipt, an article or material is found to be nonconforming, it should be returned to the supplier. The contractor shall provide the supplier with sufficient nonconformance information to allow correction of the defect and development of corrective action to preclude recurrence.

4.7.4.B RETURN FOR REWORK OR COMPLETION OF OPERATIONS
Rework or completion of operations shall be performed using established fabrication, inspection, and test documents.

4.7.4.C SCRAP
If the article or material is unfit for use, its disposition shall be assigned in accordance with approved procedures for identifying, controlling, and disposing of scrap.

4.7.4.D MATERIAL REVIEW BOARD (MRB)
All MAJOR nonconformances shall be submitted to the MRB for final disposition.

Nonconformance dispositions referred to in paragraphs 4.7.4.A through 4.7.4.C shall be subject to review by NASA or ESA, as appropriate. MAJOR nonconformances affecting the interface between the ISS and ESA projects shall be assessed by an ESA/NASA MRB when USE-AS-IS is dispositioned on either side of the interface.

4.7.5 MATERIAL REVIEW BOARD (MRB) ACTION
MRB membership and the disposition and control of affected hardware shall be based on the following:

4.7.5.A
The MRB shall be comprised of at least one representative whose primary responsibility is engineering one representative from the contractor's Quality Assurance organization, and a designated quality representative, the procuring/contracting organization, as applicable. MRB members may consult with other organizations and personnel, as required, to arrive at optimum decision. The Product Assurance representative shall be chairman of the MRB. The ESA Product Assurance representative shall be chairman of ESA/NASA MRB's which deal with

NASA generated NCR's, the NASA Product Assurance representative shall be chairman of the ESA/NASA MRB's for ESA generated NCR's.

4.7.5.B
Dispositions of nonconformances by the MRB require unanimous agreement. Decisions shall be based on intended use and criticality of the hardware; record review of earlier actions, materials, and techniques used for repair; and retest requirements necessary to revalidate functional acceptability. The board shall make one of the following dispositions and specify the action in the nonconformance document:

4.7.5.B.1 REPAIR
Repairs shall be made according to approved Standard Repair Procedures (SRP)s. When an acceptable repair cannot be performed in accordance with an MRB-approved SRP, specific repair instructions shall be documented on the nonconformance record and approved by the MRB prior to the repair activity. The MRB has sole authority for final approval and revision of SRP's.

Limitations for use shall be specified on each SRP. The existence of standard repair procedures shall not relieve the contractor or ESA or NASA (as appropriate) of the responsibility for initiating preventive action to the fullest extent.

4.7.5.B.2 USE AS IS
Nonconforming items which the MRB dispositions as suitable for use without repair may be authorized for use as is. The rationale for making a use-as-is disposition shall be documented on the nonconformance report.

4.7.5.B.3 SCRAP
If the article or material is unfit for use, its disposition shall be assigned in accordance with NASA or ESA approved procedures for identifying, controlling, and disposing of scrap.

4.7.5.B.4 WAIVERS
When the disposition affects program requirements, appropriate procurement agency approval shall be required. Waivers shall be submitted to the procurement agency configuration control board for approval. Each waive request shall include procurement agency Quality Assurance representative remarks to facilitate proper consideration of the waiver and assure correct category. Each waiver shall be submitted in accordance with the format and contents requirements of the Request for Waiver (RFW).

4.7.5.B.5 ARTICLES OR MATERIALS RETURNED TO SOURCE
Nonconforming articles or materials returned to the source and subsequently resubmitted to the customer shall bear adequate identification of such resubmission. Reference shall be made to the nonconformance document, and evidence that remedial and recurrence control actions have been taken shall be provided.

4.7.5.C MRB HOLDING AREA

Holding areas shall be established for nonconforming articles and materials pending MRB disposition. Access shall be limited to MRB members or personnel authorized by the MRB. Provisions shall be made to prevent unauthorized removal of hardware.

4.7.5.D SUPPLIER MRB
Within the limits of the applicable contract, the contractor may delegate MRB responsibility to a supplier upon determining that the supplier meets the MRB requirements of this document.

4.7.5.E RECURRENCE CONTROL
Quality Assurance shall assure the evaluation of all nonconformances to determine cause and action required to preclude recurrence. Evidence of such action shall be documented on each nonconformance report prior to close out. Recurrence control shall include, but shall not be limited to, correction of technical documents and correction of other articles and materials at all locations.

4.7.6 PROBLEM REPORTING
A closed-loop system shall be provided for reporting and correcting problems. All problems involving flight articles, flight-like articles, and GSE shall be included in this system. Detailed requirements for problem reporting, analysis, and resolution shall be in accordance with the applicable problem Reporting and Corrective Action System Requirements for the International Space Station Program or for the ESA projects. ESA projects problem reporting at the ISS integration shall be in accordance with the ISS PRACA System, once ESA has passed responsibility for End-Items handling to NASA-KSC.

4.8 METROLOGY

4.8.1 METROLOGY CONTROLS
A documented metrology system shall be established and maintained to ensure that measurement standards and equipment provide objective evidence that articles and materials produced or procured are in compliance with specifications, drawings, and program and contractual requirements. All new or repaired measurement standards and equipment shall be inspected and/or tested prior to use. Documentation of this effort shall be maintained and made available for review by the designated procuring/contracting organization quality representative, as appropriate.

4.8.2 CALIBRATION RECORDS
Individual records of measurement standards and equipment calibration shall be maintained. These records shall include, but are not limited to, the following:

4.8.2.A
Identification of standard or equipment to be calibrated

4.8.2.B
Identification of standard equipment and calibration procedure used in the calibration process

4.8.2.C

Calibration intervals

4.8.2.D
Dates and results of each calibration

4.8.2.E
Due date of next calibration

4.8.2.F
Individual(s) performing calibration

4.8.2.G
Calibration facility

4.8.2.H
Degree of nonconformance of standards or equipment received for calibration

4.8.3 MEASUREMENT ACCURACY
Unless otherwise specified by applicable standards, random and systematic errors in any article or material measurement shall not exceed ten percent of the tolerance of the article or material characteristic being measured. Authorization for exception shall be requested from the procuring procuring/contracting organization.

Random and systematic errors in any calibration measurement shall not exceed 25 percent of the tolerance of the parameter being measured unless otherwise specified by applicable national calibration/standards requirements. Authorization for exception shall be requested from the procuring procuring/contracting organization.

4.8.4 CALIBRATION CONTROLS

4.8.4.1 FACILITY
Each organization shall have its own facility for calibrating measurement standards and equipment or shall use the services of an outside facility which meets the requirements of this paragraph..

4.8.4.2 TRACEABILITY
All measurement standards shall be traceable to national standards maintained by the national institute of standards and technology or their values shall be derived from a controlled measurement process utilizing a fundamental constant of nature.

4.8.4.3 HANDLING, STORAGE, AND TRANSPORTATION
All measurement standards and equipment shall be handled, stored, and transported in accordance with documented procedures which shall preclude equipment damage or degradation of accuracy.

4.8.4.4 IDENTIFICATION AND LABELING
All measurement standards and equipment shall be uniquely identified and labeled, tagged, or coded to indicate calibration status and due date of next calibration.

4.8.4.5 CALIBRATION INTERVALS
Calibration intervals shall be established, documented, and periodically reviewed. Intervals shall depend upon the use, accuracy, type of standard or equipment, and other conditions affecting the measurement process.

4.8.4.6 RECALL SYSTEM
All standards and equipment used in measurement processes shall be recalled and re-calibrated at established intervals. Standards and equipment not re-calibrated on or before the recall due date or damaged in use shall be removed from service or otherwise restricted from use. Authorization for exception shall be obtained from the procuring organization.

4.8.4.7 ENVIRONMENTAL REQUIREMENTS
Environmental conditions (i.e., temperature, humidity, vibration, cleanliness) shall be compatible with the requirements of the article and material and calibration measurement processes.

4.8.5 REMEDIAL ACTION AND RECURRENCE CONTROL
Recurrence control shall be taken relative to nonconforming measurement standards or equipment and shall extend to the articles or materials previously measured using such equipment.

4.9 STAMP CONTROLS
Quality Assurance shall establish and maintain a documented stamp control system. The ESA requirements as provided in MS-RQ-ESA-004. The following procedures provide guidance for verification of the adequacy of contractor stamp control procedures:

4.9.A STAMP AND MARKING MATERIALS
Stamps, decals, seals, torque wax, paints signatures, and other marking devices or materials shall be used, are appropriate, to identify that articles and materials have undergone source and receiving inspection; in-process fabrication and inspection; end-item fabrication and inspection; and end-item testing, storage, and shipment.

4.9.B STAMP TRACEABILITY
Stamps shall be traceable to individuals responsible for their use, and records shall be maintained to identify individuals with specific stamps. Unissued stamps shall be kept secure to prevent unauthorized use. Stamps issued to personnel being transferred or terminated shall be returned and shall not be reissued for a period of at least six months. Worn or damaged stamps shall be destroyed at the time replacements as issued. The identification symbols (e.g., numbers and letters) of lost stamps shall be withdrawn from use. The use of any stamp by an individual other than the holder of record is specifically prohibited. Periodic checks shall be made to assure that stamps are in possession of the individual to whom they are issued and that they are not worn or damaged.

4.9.C STAMP APPLICATION
Stamps shall be applied to records to indicate the fabrication or inspection status of associated articles and materials.

4.9.D ELECTRONIC DATA CONTROL
Verification/validation/acceptance requirements for computerized data entry and retrieval systems and computer generated drawings and documents shall address alternatives to stamp use for certification.

4.9.E STAMPING/MARKING APPLICATION
Stamps shall be applied to tags, cards, or labels or attached to individual articles and materials or their containers as appropriate.

4.9.F STATUS STAMPING
Stamps indicating that fabrication, inspection, or test operations have been performed may be applied directly to articles and materials.

4.9.G STAMPING METHODS
Stamping methods and marking materials must be compatible with the articles and their use.

4.9.H STAMP SIGNIFICANCE
An up-to-date description and explanation of the significance of all stamps shall be maintained.

4.9.I CONTRACTOR STAMP DESIGNS
The design of contractors' stamps shall be such that fabrication and inspection stamps are distinctly different. Contractor stamps shall not exhibit the designation "NASA," abbreviations of any NASA installation, or the designation or abbreviations of ESA.

4.10 HANDLING, STORAGE, PRESERVATION, MARKING LABELING, PACKING AND SHIPPING

4.10.1 PROCEDURES AND INSTRUCTIONS CONTROL
Quality Assurance shall concur, prior to their release, in the controls for handling, storage, preservation, marking, labeling, packaging, and shipping operations.

Effective implementation of these documents shall be assured through controls monitored by Quality Assurance in accordance with approved documentation.

4.10.2 HANDLING
Handling, hoisting, or lifting equipment (e.g., slings) shall be prominently marked to indicate the maximum load capacity and the due date of the next rated or periodic load test. Quality Assurance personnel will verify that the required tests and maintenance are accomplished within the specified frequency.

4.10.3 STORAGE
Storage areas for articles and materials shall be controlled. The controls shall include the following:

4.10.3.A
Controlled acceptance into and withdrawal from the storage area.

4.10.3.B
Positive identification of limited-life material and removal of materials with expired shelf life.

4.10.3.C
Periodic inspection of stored material, housekeeping and record keeping

4.10.3.D
Systematic inspection and/or testing necessary to ensure maintenance of preservation including special environments

4.10.4 PRESERVATION
Quality Assurance shall verify that articles and materials subject to deterioration, corrosion, or contamination are preserved by documented methods which ensure adequate protection.

4.10.5 PACKAGING AND PACKING
Quality Assurance shall verify that packaging and packing material, procedures, and instructions are used and that they provide for protection of articles and materials before shipment, during transportation, and after arrival at the destination.

Special attention shall be directed toward critical, sensitive, dangerous, and high-value articles. Reusable containers shall be inspected prior to each use.

4.10.6 MARKING AND LABELING
Quality Assurance shall verify that marking and labeling for packaging, storage, and shipping of articles and materials are performed in accordance with applicable specifications. This marking and labeling shall include such information as complete article or material identification, cleanliness level, environmental requirements, packaging orientation arrows.

Caution and Warning (C&W) notes, life-expiration dates, location of data package, and transportation as applicable. Special attention shall be given to critical, sensitive, dangerous, and high-value articles.

4.10.7 SHIPPING

4.10.7.1 CONTROLS
Quality Assurance shall verify the following:

4.10.7.1.A
Articles and materials have been prepared and packaged in accordance with applicable procedures and requirements and have been properly identified and marked.

4.10.7.1.B
Accompanying documents have been properly identified as to inspection status by appropriate inspection stamps and the data package is complete.

4.10.7.2 UNSCHEDULED REMOVAL

The contractor shall notify the designated procuring/contracting organizations' quality management in the event of any unscheduled removal of an article or material from its container. The extent of re-inspection and retest shall be authorized by quality management of the procuring/contracting organization.

4.11 SAMPLING PLANS, STATISTICAL PLANNING, AND ANALYSES

4.11.1 SAMPLING PLANS

Sampling plans may be used when inspection tests are destructive or when data, inherent characteristics, or the non-critical application of an article or material indicates that a reduction in inspection or testing will not jeopardize quality, reliability, or design intent. When sampling techniques are to be employed, MIL-STD-105D, Sampling Procedures and Tables for Inspection by Attributes, or MIL-STD-414, Sampling Procedures and Tables for Inspection by Variables for Percent Defective, whichever is appropriate, may be used.

4.11.2 STATISTICAL ANALYSES

Statistical analysis techniques may be used where such use will provide effective control over fabrication and inspection operations especially in those areas where special processes and equipment are difficult to control.

4.12 CONTROL OF NASA AND INTERNATIONAL PARTNER PROPERTY

4.12.1 CONTRACTOR RESPONSIBILITY

Contractor Quality Assurance shall ensure that a documented system for controlling NASA and ESA property and associated documentation has been established and is maintained as follows:

4.12.1. A

Upon receipt, contractor Quality Assurance shall inspect NASA and ESA property to detect damage in transit and to verify that the article and its ADP are complete and a specified in the shipping documents. Articles found to be serviceable shall be re-preserved and repackaged unless the articles are to be used immediately. Should there be evidence of damage in transit, the article shall be inspected to determine the extent of damage and a report of the damage provided to the designated NASA or ESA representative. Receiving inspection results shall be recorded in the historical record for the article.

4.12.1.B

When functional testing is performed on NASA and ESA property during receiving inspection or prior to installation into the next level of assembly, the designated NASA or ESA representative shall be notified and may participate in the testing activity, if this functional testing has been identified as a MIP or KIP according to the rules of the applicable contract.

4.12.1.C

Documented procedures shall describe the control of approved storage areas for NASA or ESA property. Controls shall include the following:

- Limited personnel access
- Controlled receipt and withdrawal
- Identification of article status
- Inventory list of articles in the area
- Scheduled inspection of the area and periodic verification of the inventory list
- Controls for items that must be environmentally protected

4.12.1.D
The contractor shall provide for the protection, maintenance, calibration, periodic inspection, segregation, and controls necessary to ensure the quality of NASA and ESA property is maintained and that damage and deterioration do not occur during handling, storage, installation, or shipment.

4.12.1.E
NASA and ESA property shall not be diverted or loaned from its assigned purpose without the prior approval of the designated NASA or ESA project management.

4.12.2 UNSUITABLE NASA OR INTERNATIONAL PARTNER PROPERTY
NASA and ESA property found to be damaged or otherwise unsuitable for its intended use shall be identified as non-conforming, segregated to the extent practicable, held for review, and analyzed to ascertain the probable cause of damage. When the cause is determined to be in the contractor's operations or activities, action shall be taken to prevent recurrence. “Use-as-is” disposition shall not be assigned to discrepant NASA and ESA property nor shall this property be reworked, repaired, modified, or replaced without the specific written authorization of NASA or ESA project management.

5.0 SOFTWARE PRODUCT ASSURANCE (SPA)

SPA is a technical discipline which establishes requirements and criteria for the evaluation, assessment, assurance and enhancement of software safety, reliability, maintainability and quality. It is to be accomplished to the extent specified for ESA projects software, including flight software safety, reliability, maintainability and quality. It is to be accomplished to the extent specified for ESA projects software, including flight software, flight support software, software used for their design, development, verification, storage and maintenance, and software that controls or could effect flight hardware of software. SPA requirements apply to the software portions of a system. Assurance of a system shall include software affecting the system safety, reliability, maintainability or quality, and shall emphasize the use of preventive as well as corrective methods.

System Product Assurance requirements for hardware and operational procedures are addressed only as they relate to software.

Software that is developed for usage in the ESA projects flight configuration and which is to be loaded in a class of memory that cannot be dynamically modified (i.e., firmware) is subject to these software assurance requirements.

5.1 MANAGEMENT

Software product assurance activities shall be planned, managed, and accomplished in conjunction with other management and technical functions to satisfy program requirements.

5.1.1 ORGANIZATION

Project management shall assure that SPA accountability shall be independent of the development organization. SPA management shall be structured to provide planning, management, and implementation of all SPA activities. While the accomplishment of all SPA tasks may not be the responsibility of a single organizational element, management or the SPA activities shall be coordinated with project management to ensure that all SPA requirements are assigned to the appropriate organization. SPA management shall have direct access to project management.

5.1.2 SOFTWARE PRODUCT ASSURANCE PLANNING

SPA activities shall be planned and implemented throughout the software life-cycle in compliance with MS-RQ-ESA-004.

5.1.3 FORMAL AND INTERNAL REVIEWS

SPA shall participate in formal program, project, and software reviews to evaluate accomplishment of SPA requirements. SPA shall participate in developer reviews of software requirements, design, test readiness and test results.

5.1.4 SUBTIER REQUIREMENTS

It shall be assured that the applicable requirements in this document are flowed down and adhered to by contractors, and their sub-tier providers of software.

5.1.5 NON-DEVELOPMENTAL SOFTWARE

SPA shall assure that non-developmental software to be incorporated into deliverable software is evaluated to assure that:

a. Objective evidence exists, prior to its incorporation, that it performs its required functions
b. It is placed under contractor internal configuration management control prior to its incorporation into the developmental configuration
c. The data rights provisions are consistent with contractual and program requirements.

5.1.6 NASA OR ESA FURNISHED SOFTWARE

When software, and related documentation is furnished to a contractor by NASA or ESA, accompanying SPA-related information shall be reviewed. If it is determined that the characteristics of the software are not consistent with the requirements placed upon it, NASA or ESA, as appropriate, shall be promptly and formally notified.

5.1.7 PROGRESS REPORTING

SPA activities shall be reported through periodic management meetings and status reports.

5.1.8 CONTROL BOARDS

As a part of the Product Assurance/Safety organization, SPA participates in configuration activities and other formal control boards for software issues to assure that software related safety, reliability, maintainability and Quality Assurance requirements are met.

5.1.9 OPERATIONS AND MAINTENANCE

Systematic methods shall be provided for evaluation of the operational use of the software for activities including installation, planned and unplanned maintenance, and upgrades. The methods shall include an evaluation of compatibility between the application of the software and that software's functional requirements and design constraints. The evaluation shall include review of planning for operations and maintenance. The process shall provide assurance for the retention of safety, reliability, maintainability, and quality attributes and that maintenance activities will not adversely affect the required fault tolerance.

5.1.10 TRAINING

SPA personnel performing inspections or analyses shall have the proper training and qualifications.

5.1.11 SPA TOOLS

For ESA projects developed software, the Software Development Environment (SDE) will provide tools, rules, procedures and standards for SPA and shall be used to the extent practicable.

5.2 SOFTWARE QUALITY ASSURANCE

Software development or acquisition shall be evaluated. It shall be assured that: standards and procedural controls are established and implemented; audits, evaluations, and reviews are accomplished; procedures are followed; and all assurance activities are performed as scheduled.

5.2.1 AUDITS

On both a scheduled and unscheduled basis, all activities conducted as part of the software life-cycle such as development, documentation, testing, configuration management, nonconformance reporting and corrective action activities shall be audited. Compliance with approved standards and procedures for these activities shall be verified.

5.2.2 TOOLS, TECHNIQUES, AND METHODOLOGIES

For the ESA projects, all tools, techniques, and methodologies that support the software development and acquisition processes shall meet the ESA approved software engineering and product assurance/safety standards.

5.2.3 SOFTWARE DOCUMENTATION

Software documentation shall be evaluated to ensure that the ESA approved documentation standards are satisfied. Acquisition and development plans and procedures shall be evaluated to ensure that appropriate SPA tasks are included. ESA projects' related software documentation shall be assessed against applicable ESA standards for all deliverable software. The measures applied to ensure delivery of correct, complete and compliant documentation and change information shall be monitored. Software design documentation shall be assessed at the architectural and detailed levels for adherence to approved software documentation standards and procedures.

SPA reviews of documentation of all interfaces, including hardware-to-software, software-to-software, and user-to-software shall assure that control documents exists and conform to applicable standards.

Nonconformances found shall be categorized as per MS-RQ-ESA-004 and shall be reported in accordance with the nonconformance reporting requirements applicable to the ESA project.

5.2.4 SOFTWARE CODE INSPECTION

SPA shall verify completion of software code inspections prior to integration and testing to assure compliance with design requirements.

5.2.5 SOFTWARE TESTING

For all deliverable software formal testing, SPA shall:

a. Verify, consistency between the configuration and configuration documentation of the software, assure issue of approved and correct versions for testing and assure that only approved changes are made.
b. Assess test plans, procedures, and related documentation for compliance with documentation standards.
c. Monitor tests and review test results; selectively witness certification activities to ensure that test procedures have been performed, all acceptance criteria met, and that actual test results are recorded.
d. Assure detected nonconformances are reported in accordance with the nonconfromance reporting requirements.
e. Review and assess test reports for completeness.

f. Assure that test related documentation and test setups are maintained to allow test repeatability.

5.2.6 SOFTWARE LIFE-CYCLE PROCESS EVALUATION

The ESA project's software life-cycle processes shall be evaluated to identify and eliminate or control real and potential problems which could introduce nonconformances into the software product. Upon ESA approval of a process, any change to that process shall require re-evaluation and re-approval.

SPA shall assure that software life-cycle processes and tools such as compilers and code checkers are maintained to an approved configuration and properly operating following any modification or update.

5.3 CONFIGURATION MANAGEMENT

The joint ESA/NASA configuration management of ISS software are given in SSP 41170. The following configuration management processes shall be assured: configuration identification; configuration status accounting; configuration change control; configuration verification; and software delivery. The ESA configuration control requirements applicable to the ESA projects are given in MS-RQ-ESA-004.

5.3.1 CONFIGURATION IDENTIFICATION, STATUS ACCOUNTING AND VERIFICATION

Software baselines established at the end of life-cycle phases, including configurations delivered for formal testing or for operational use, shall be evaluated or audited and verified that the baselines and configurations are correct and the proper result of the configuration management process has been implemented.

5.3.2 CONFIGURATION CHANGE CONTROL

The processing and implementation of change requests which affect controlled configurations shall be evaluated and monitored to assure that the change results in a product which conforms to baselined requirements and standards and that the change is incorporated in accordance with approved procedures. Change requests shall be reviewed for impact on software safety, reliability, maintainability, and quality. The ability of the providing organization to implement and verify the change within approved life-cycle processes shall be assured.

5.3.3 SOFTWARE DELIVERY

There shall be a process to assure that required deliverables are complete and conform with established delivery requirements. ESA projects software delivery is controlled by the ESA product assurance/safety requirements MS-RQ-ESA-004 and the corresponding, ESA approved, procedures/standards. Final software delivery will be part of the ESA Final Acceptance process which includes the deliverable items and an ESA Certificate of Acceptance.

5.3.4 SOFTWARE LIBRARIES

Software libraries shall be audited and their processes evaluated to assure adherence to baseline configuration management processes. The audits and evaluations shall assure that different

computer program versions are accurately identified and documented, that only authorized modifications are made, that modifications are made in accordance with controlled documentation, and that software submitted for testing or operation is the required version.

5.4 NONCONFORMANCE REPORTING AND CORRECTIVE ACTION

For the ESA projects, the requirements of the process for reporting, analyzing and correcting of nonconformances in the software, documentation, associated data and operational procedures are provided in MS-RQ-ESA-004.

5.4.1 NONCONFORMANCE REPORTING

For ESA, the implementing systems shall record information in accordance with the nonconformance system required by MS-RQ-ESA-004. The nonconformance reporting and corrective action reporting systems shall allow the generation of summary and detailed reports.

5.4.2 CORRECTIVE ACTION

SPA shall ensure that procedures are in place to evaluate the impact of a reported nonconformance, the resources required for corrective action, and the impact of not taking corrective action. The procedures shall ensure the requirements for adequate re-testing of the corrected nonconformance and the process for the inclusion of the corrected item in new versions of the software.

5.4.3 ISS PROBLEM REPORTING AND CORRECTIVE ACTION

Software nonconfromances shall be reported and dispositioned in accordance with requirements in section 4.7

5.5 RELIABILITY AND MAINTAINABILITY ASSURANCE

Software reliability and maintainability assurance activities shall be conducted in all life-cycle phases in accordance with MS-RQ-ESA-001 and MS-RQ-ESA-004.

5.5.1 TRADE STUDIES

SPA shall participate in trade studies and their results shall be assessed to ensure that appropriate reliability and maintainability requirements are included.

5.5.2 STANDARDS

SPA shall assure that software development standards are established and implemented.

5.5.3 FORMAL SOFTWARE REVIEWS

At formal software reviews, software requirements derived from system reliability and maintainability requirements shall be assessed.

5.5.4 NONCONFORMANCE ANALYSIS

5.5.5 REQUIREMENTS

Development of and changes to requirements shall be evaluated to assure inclusion of and consistency with software requirements derived from system reliability and maintainability

requirements. Analysis shall be done of the traceability of requirements to design, to code, and to test and back to assure satisfaction of all requirements and exclusion of unauthorized functions.

5.5.6 DESIGN ANALYSES

Reliability and maintainability analyses shall be performed on the architecture and the design to assure incorporation of software requirements derived from system reliability and maintainability requirements. Reliability and maintainability shall participate in the assessment of reusable software for use in lieu of a new design.

5.5.7 FAULT TOLERANCE ANALYSIS

ESA projects' software shall be classified in accordance with the functional criticality of the function in which the software is a part.

All software shall be categorized according to the categories specified in MS-RQ-ESA-001.

Implementation standards shall be established for each category of software, with as a minimum IV&V, (or equivalent) being applied to the highest category of software.

The design of the software shall not compromise the system level failure tolerance requirements. Fault tolerant software techniques shall be used for the highest category of software to the extent that such techniques are applicable and effective in the specific application.

Analysis shall be performed to initially classify the software and to determine the effects on safety and mission critical functions.

5.5.8 SOURCE CODE EVALUATION

Source code shall be evaluated to assure implementation of software requirements derived from system reliability and maintainability requirements.

5.5.9 TEST

Test plans and requirements shall be evaluated to assure performance of tests which demonstrate the implementation of all software requirements derived from system reliability and maintainability requirements. The results shall be evaluated to assure documented evidence of system performance and disposition of all nonconformances.

5.6 SOFTWARE SAFETY ASSURANCE

SPA shall assure analyses of software are performed on software directly involved in the control o functions associated with safety criticality categories I and II, or where software malfunction or faults will lead to events with safety critical consequences.

5.7 INTEGRATION ASSURANCE

SPA shall ensure that a process exists to evaluate and integrate the software-to-hardware interfaces, software-to-software interfaces, and software-to-user interfaces of the system to meet the requirements defined in the interface documentation and those contained in SSP 30459, Space Station Interface Development Process Requirements.

5.8 VERIFICATION AND VALIDATION

There shall be a process to assure the qualification of software in accordance with applicable requirements.

5.9 INDEPENDENT VERIFICATION AND VALIDATION

For NASA software, SPA shall ensure that IV&V is performed in accordance with applicable requirements. For ESA projects the highest category software, the Independent Software Qualification (ISQ) requirements of MS-RQ-ESA-004 shall be met. These are detailed in the ESA approved procedures/standards for ISQ.

5.10 CERTIFICATION

SPA shall ensure that products requiring certification meet the following prerequisites:

a. Verification that the software products were developed and supported according to an approved process.
b. Verification that all software products are present, complete, current and controlled and that no open nonconformances exist which are safety or mission critical.
c. Validation that the software products meet all of the applicable requirements including safety and reliability requirements.
d. Software provided by ESA shall be certified by ESA, after formal qualification and acceptance.

5.13 SECURITY AND PRIVACY ASSURANCE

SPA shall ensure that applicable system security and privacy requirements have been implemented.

5.14 IDENTIFICATION AND DATA RETRIEVAL

SPA shall assure that a documented identification and data retrieval system is implemented and maintained. The system shall be configured to assure product traceability.

The record retention system shall assure that records are identified and related to applicable software products that can be located and retrieved. Records shall be retained in a safe, accessible location. The retention period for ESA projects related software will be specified by ESA

6.0 SAFETY

6.1 SAFETY MANAGEMENT

6.1.1 SAFETY APPROACH

Safety management activities shall be an integral part of the ISS, Design Development process, and shall be developed, planned, and implemented to assure that hazards and their consequences are identified, evaluated, and controlled during all phases of the ESA projects. These activities shall provide an overall safety risk assessment including identification of residual hazards, and retention rationale for program management decision on acceptance. The safety program shall encompass all activities of the ESA projects and its interface to the ISS Program. The safety planning for the ESA projects and its interface to the ISS shall implement the requirements of COL-RQ-ESA-001 (SRD) and MS-RQ-ESA- 004 (PA/S Requirements) and jointly agreed interface and data requirements between ESA projects and ISS.

6.1.2 ORGANIZATION

Organization of the safety effort shall assure effective planning, management, implementation and performance of system safety, industrial safety, and test operations activities. While the accomplishment of all safety tasks may not be the responsibility of the same organizational element, management of the safety efforts shall assure that all tasks are effectively accomplished. Safety management shall have direct access and shall report regularly to the program/project manager who has the responsibility for risk management decisions.

6.1.3 LAUNCH SITE SAFETY PLAN

A launch site safety plan shall be prepared by ESA. The safety planning for the ESA projects and its interface to the ISS Program shall be defined and agreed upon in coordination between the Launch Site Safety Organization and ESA. The plan shall be approved by the Launch Site Safety prior to first hardware delivery to the launch site. The plan shall be in conformance with applicable launch site safety requirements.

6.1.4 SAFETY REVIEW REQUIREMENTS

6.1.4.1 SPACE STATION REVIEW AND CERTIFICATION

A safety review process shall be established and maintained to evaluate the safety processes of the International Space Station (ISS) in agreement with SSP 30599 procedures and to assess compliance with safety requirements. The ESA project' Safety Review Process is described in MS-ESA-PR-004. Data to support this process will be in accordance with the Data Exchange Agreements.

The safety organization shall support the following reviews and boards:

(1) ESA project Milestone Reviews. ESA projects safety assessments shall be an integral part of ESA project milestone reviews, such as Preliminary Design Reviews (PDR's) and Critical Design Reviews (CDR's), etc. The safety reviews at each program level shall address the appropriate phases of the ESA projects including manufacturing, handling, ground transportation, NSTS hazards for ground and flight operations, and the ISS-operations.

6.1.4.2 SPACE STATION USER PAYLOAD SAFETY REVIEWS

This is not a subject of this document as ESA payloads are not the responsibility of the ESA Manned Space Flight Program Department.

6.1.5 SAFETY AUDIT TEAMS AND SURVEYS

Safety Audit Teams selected from the applicable NASA or ESA organizations will conduct safety audits and reviews of safety organizations, programs and activities. By joint agreement, NASA safety representatives will be invited to participate in ESA audit and review activities. Safety program audits and survey reviews shall be scheduled in advance in accordance with guidelines provided to the organization being audited by the auditing organization. A file of the review results shall be maintained. NASA and ESA shall have the right to participate in contractor and subcontractor safety surveys addressing an Space Station Element (SSE) for which it has responsibility.

6.1.6 MISHAP REPORTING AND INVESTIGATION

Mishaps (as defined in Appendix B) occurring during manufacturing, testing, handling, transportation and operations which have the potential for impact to verified compliance with defined flight hardware performance and build standard criteria (flight worthiness) shall be investigated and reported to NASA. Mishaps with potential for impact to flight worthiness will be reported using the CPRACA procedure, any resulting schedule impact shall be reported through the provisions of the applicable joint management agreements.

Technical assistance shall be provided to NASA or ESA boards investigating mishaps that are within their jurisdictions. The NASA or ESA organizations, will cooperate fully with the investigation and will provide any records, data, trends, and other administrative or technical support and services as necessary.

6.1.7 SAFETY TRAINING AND CERTIFICATION

Personnel who perform hazardous operations and activities shall be appropriately trained and certified. The safety organization shall participate in the development of the training activities and shall approve the programs that are developed. Positions requiring training and certification shall be identified. A current record of certification status according to mission, configuration, and locations shall be maintained. Protective devices and emergency equipment shall be identified and included in safety training. Hazards will be brought to the attention of trainees. Proficiency demonstrations of training, to the degree feasible, will be required for hazardous operations. Personnel training and certification shall be in accordance with procedures and regulations applicable at the particular site.

6.1.8 WAIVERS

Safety shall evaluate proposed hardware, software, and operational waivers and recommend disposition for management concurrence. Where the evaluation establishes the presence of a potential hazard not yet covered by safety analyses, a hazard report will be initiated, or an existing hazard report will be updated to show the risk status.

6.2 SYSTEM SAFETY

6.2.1 SYSTEM SAFETY OBJECTIVES

The system safety objectives are to identify and evaluate ESA projects design and operational activities to assure that measures are taken to minimize risks. The system safety objectives shall be accomplished using MS-RQ-ESA-004 which includes the following:

6.2.1.A Performing safety analyses to identify the hazards associated with hardware, software, and operations during all program phases

6.2.1.B Assuring that proper design and performance requirements eliminating or controlling the identified hazards are developed, documented, and implemented

6.2.1.C Performing an overall risk assessment including the identification of residual hazards/risks and providing recommendations with supporting data and rationale for management awareness and decision on acceptance of the residual hazards/risks.

6.2.1.D Assuring that the Operating and Support Hazard Analysis, includes evaluation of on-orbit assembly procedures.

6.2.2 ESA PROJECTS SYSTEM SAFETY TECHNICAL REQUIREMENTS

Safety technical requirements contained in the SSP 41160 as well as XXX-ESA-RQ-001 shall be identified and incorporated in system design, operations, and procurement documentation including facilities, GSE, and flight hardware and safety critical software. A system to show compliance with these requirements shall be developed, implemented, and maintained. The system shall provide verification. The verification system will be used to do the following: maintain current requirements documents and reference the next higher or lower requirement document, assure specific requirements are imposed, and report implementation status of requirements.

6.2.3 SAFETY ANALYSES

Safety analyses shall be performed in accordance with ESA document MS-RQ-ESA-004 . SSP 30309 and MS-RQ-ESA-004 provide instructions for performing analyses, implementing the safety risk management, and applying criteria for risk assessment.

6.2.4 HAZARD ELIMINATION AND CONTROL

The foremost consideration for resolving hazards shall be to eliminate them by design through removal of hazard sources and hazardous operations. Corrective action priorities shall be established to achieve maximum benefit in reducing potential personnel and material losses.

6.2.5 HAZARD REPORT CLOSURE CONTROL

A hazard report shall be considered closed after it has been demonstrated that the hazard has been eliminated by a design or operational change, and the change has been implemented or when residual risks have been controlled to a level of risk which is acceptable by Program Management.

Project/program management acceptance of residual hazards shall be based on evaluation and assessment of data and documentation which provide the required data for the acceptance rationale.

6.2.6 HUMAN ENGINEERING

To minimize human errors, procedures and criteria shall be developed to assure that safety-related human engineering principles are applied in accordance with SSP 50005, ISS Flight Crew Integration Standard and ESA Standard MS-RQ-ESA-013 to eliminate or mitigate potential hazards associated with the man-machine interface during design, development, manufacture, test, maintenance, and operation of the system or subsystem.

6.2.7 SPECIFICATIONS AND PROCEDURES REVIEW

Specifications, standards, and procedures for manufacturing, testing, maintenance, and operations shall be reviewed to assure that adequate warnings are included and that the inherent safety of the design is preserved.

6.2.8 NASA OR INTERNATIONAL PARTNER FURNISHED EQUIPMENT SAFETY (GFE/IGFE)

(1) Safety data needed for AFE shall be identified by the contractor or supplying agency and shall be supplied by the supplying agency. When examination of these data or testing indicates that AFE and/or AFE documentation is not consistent with the safety requirements, the safety organization of the supplying agency shall be formally and promptly notified.

(2) General Requirements: Hardware/software shall meet the requirements of the overall system regardless of its source. The level of requirements imposed on contractors, suppliers of such equipment shall be consistent with those imposed on the system. NASA and/or ESA are responsible for assuring that this equipment is integrated into systems or hardware for which they are responsible.

(3) Integration: The safety impact of integrating NASA or ESA furnished equipments into a system shall be analyzed. Safety data for these equipments shall be provided to the contractor(s) by the responsible Agency. When examination of this data or testing indicates an inconsistency with the safety requirements of the overall system, the responsible Agency shall be promptly notified.

6.2.9 GROUND SUPPORT EQUIPMENT (GSE) SAFETY

The safety analysis approach described in paragraph 6.2.3 shall apply to ground operations involving flight and ground hardware/software and NASA provided facilities.

6.2.10 REVIEW OF CHANGES

When changes are proposed for equipment design (hardware and Software) or procedures, the safety organization shall assure the identification and resolution of hazards that may be introduced into the system. These hazards shall be documented on hazard reports. Based on this review, the safety organization shall provide concurrence or non-concurrence with proposed changes through participation in Configuration Control Board (CCB) activities.

6.2.11 REVIEW OF FLIGHT AND GROUND HARDWARE FAILURES

The safety organization shall review, provide recommendations and concur in failure resolutions associated with catastrophic and critical hazards and also monitor lower criticality failure resolutions for safety impact. Safety participation in the failure resolution activity will be consistent with the requirements MS-RQ-ESA-004.

6.2.12 EVALUATION OF GROUND AND FLIGHT TEST RESULTS

Safety shall assure evaluation of the results of testing that verifies design safety compliance. Emphasis will be placed on test plans and procedures, reports, and verification of safety parameters.

6.2.13 EVALUATION OF MISSION OPERATIONAL ACTIVITY

Safety shall participate in review of mission/operation scenarios operational and make safety evaluations of potentially anomalous conditions. These safety evaluations will provide guidance to plan future activities and to establish necessary corrective actions.

6.3 INDUSTRIAL SAFETY

NASA or the ESA (or their designated representatives) shall ensure implementation of industrial and personnel safety functions in accordance with the industrial safety and occupational health and safety government regulations applicable at the particular site. The following documents are applicable for sites in the USA: NHB 1700.1 (V1-A), Basic Safety Manual; NHB 1700.1 (V9), Fire Protection; and NASA procurement regulations identified in the general provisions schedule.

APPENDIX A ABBREVIATIONS AND ACRONYMS

ADP	Acceptance Data Package
AFE	Agency Furnished Equipment
APM	Attached Pressurized Module
AR	Acceptance Review
C&W	Caution and Warning
CCB	Configuration Control Board
CDR	Critical Design Review
CEI	Contract End Item
CIL	Critical Items List
COA	Certificate of Acceptance
COL	COLUMBUS (used in ESA documents identifier)
CPRACA	Columbus Problem Reporting and Corrective Action
EEE	Electrical, Electronic, and Electromechanical
ESA	European Space Agency
ESD	Electrostatic Discharge
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Modes, Effects, and Criticality Analysis
FSE	Flight Support Equipment
GFE	Government-Furnished Equipment
GSE	Ground Support Equipment
IGFE	International Partner Government Furnished Equipment
ISQ	Independent Software Qualification

ISS	International Space Station
IV&V	Independent Verification and Validation
JPDRD	Joint Program Definition and Requirements Document (JESA 30000)
KIP	Key Inspection Point
MIL	Military
MIP	Mandatory Inspection Point
MRB	Material Review Board
NASA	National Aeronautics and Space Administration
NCR	Non-Conformance Report
NDE	Nondestructive Evaluation
NHB	NASA Handbook
NSTS	National Space Transportation System
ORU	Orbital Replaceable Unit
OSE	Orbital Support Equipment
OTS	Off-The-Shelf
PA/S	Product Assurance and Safety
PDR	Preliminary Design Review
PDRD	Program Definition and Requirements Document
PRACA	Problem Reporting and Corrective Action
PSS	Procedure Specification Standard (used in ESA document identifier)
RFW	Request For Waiver
RQ	Requirement (used in ESA document identifier)

S&MA	Safety and Mission Assurance
S&PA	Safety and Product Assurance
SCC	Space Components Coordination
SDE	Software Development Environment
SPA	Software Product Assurance
SQA	Software Quality Assurance
SRB	Safety Review Board
SRD	System Requirement Document
SRP	Standard Repair Procedure
SSCB	Space Station Control Board
SSE	Space Station Element
SSPE	Space Station Program Element
STD	Standard
TBD	To Be Determined
USA	United States of America

*APPENDIX B GLOSSARY OF TERMS

(Per JESA 30000: To be provided in a Joint ESA/NASA Safety and Product Assurance Terms Document.) This appendix contains the definition of terms to be utilized in the interpretation and development of ISS S&MA requirements.

ACCIDENT- An unplanned event that results in personnel fatality or injury; damage to an ISS element, to the environment, or to public or private property; or the loss of any ISS-elements. See Incident.

ADDITIONAL MAINTENANCE ITEM - Any Orbital Equipment designated by the Product Group/International Partner and approved at the system or subsystem Critical Design Review (CDR) that is not an ORU but can be expected to require on-orbit maintenance (including inspection) during the life of the program and/or will require logistics resources planning.

AIRBORNE SUPPORT EQUIPMENT - The flight equipment and systems, such as test equipment, tools, gages, handling devices, etc., needed to support ISS operations from assembly through end-of-life.

AVAILABILITY - The probability that an item will be in a satisfactory operating condition at a random point in time.

CERTIFICATION - A process which may be incremental, by which a contractor provides objective evidence to the contracting agency that an item satisfies its specified requirements.

CERTIFICATION ANALYSIS - Analysis performed to satisfy certification objectives when testing under simulated mission conditions is not feasible or cost effective or the need exists to extrapolate test data beyond the performed test points or analysis performed to show that an article is similar or identical in design, manufacturing process, and quality control to another that has been previously certified to equivalent or more stringent criteria.

CERTIFICATION TESTING - The process of conducting tests which normally are considered qualification tests plus specific additional tests of components and subsystems and higher levels of assemblies required to certify that the hardware design meets established design requirements. Certification testing does not generally include development, piece-part qualification, acceptance, or checkout tests except where such tests are specifically identified as required for certification.

CORRECTIVE ACTION - Action taken to preclude occurrence of an identified hazard or to prevent recurrence of or resolve a problem.

CRITICAL CHARACTERISTICS - Any physical attribute of an article or material which if defective can cause loss of life or equipment, or make the article or material nonfunctional.

DESIGN SPECIFICATION - Generic designations which describe functional and physical requirements for an article, material, or service.

FAIL OPERATIONAL - Having the ability to sustain a failure and retain full operational capability.

FAIL SAFE - The ability to sustain a failure and retain the capability for safe crew and ISS operations.

FAILURE (ESA) - The consequences of faults, data and human errors, or anomalies resulting in the inability of an item to perform as specified.

FAILURE (ISS) - The inability of a system, subsystem, component, or part to perform its required function within specified limits under specified conditions for a specified duration.

FAILURE TOLERANCE (ESA) - The capability of a system or function to tolerate a defined number of failures. For safety related failure tolerance: this definition applies when the loss of a system/function or the inadvertent occurrence of an event in a system/function results in a hazardous situation.

FAILURE TOLERANCE (ISS) -

1. The ability to continue to operate in the presence of anomalies or failures.
2. The number of failures which can be allowed without disruption of nominal functional performance.

FAULT DETECTION - The capability of testing equipment or systems to give an operator or technician a go/no-go indication.

FAULT ISOLATION (ISS) - The capability of testing equipment or systems to indicate to the technician where the failure has occurred.

FAULT TOLERANT - Having the built-in capability to provide continued correct execution in the presence of an allowed number of hardware or software faults.

GROUND SUPPORT EQUIPMENT - GSE is that contract deliverable equipment (hardware/software) used on the ground to test, transport, access, handle, maintain, measure, calibrate, verify, service and protect flight hardware/software.

HAZARD - An existing or potential condition that can result in a mishap.

INCIDENT - An unplanned, minor event or episode that can lead to an accident. See Accident.

LIMITED-LIFE ITEM - Any item designated as having a limited useful life in relation to its application. Limited life includes operating time or cycles and age life.

LINE REPLACEABLE UNIT - An item which can be removed from a system and replaced as a unit at the organizational level of repair action.

MAINTAINABILITY - Characteristics of design and installation of an item which enables it to be retained in or restored to a specified operational condition by using prescribed resources and procedures.

MAINTENANCE - The function of keeping an item in or restoring it to a specified operational condition.

MISHAP - Event that results in death, injury, or illness of NASA/NASA contractor personnel; in damage to property or equipment; or in a mission or test failure that has significant program impact or visibility.

NONCONFORMANCE - A condition of any article or material or service in which one or more characteristics do not conform to contractual requirements. Includes failures, discrepancies, defects, and malfunctions.

OFF-THE-SHELF HARDWARE - Production of existing design hardware (black box, component) used in or for the NASA, military, and/or commercial programs.

OFF-THE-SHELF DESIGN - An existing design for equipment with known characteristics and proven history that has not been manufactured.

OFF-THE-SHELF EQUIPMENT - Equipment of an existing design that has been manufactured and is available for delivery.

OPERATING CYCLES - The cumulative number of times an item completes a sequence of activation and returns to its initial state.

OPERATING LIFE - The maximum operating time or cycles which an item can accrue before replacement or refurbishment without risk of degradation of performance beyond acceptable limits.

ORBITAL REPLACEABLE UNIT - The component or subsystem hardware that is designated by the Product Group/International Partner and approved at the system or subsystem CDR to be removed and replaced under orbital conditions, and that has not been designated as an AMI.

OFF-THE-SHELF HARDWARE - Production of existing design hardware (black box, component) used in or for the NASA, military, and/or commercial programs.

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ORBITAL REPLACEABLE UNIT - The component or subsystem hardware that is designated by the Product Group/International Partner and approved at the system or subsystem CDR to be removed and replaced under orbital conditions, and that has not been designated as an AMI.

PROBLEM
- Any nonconformance which fits or which is suspected of fitting one of the following categories:
- Failure or unsatisfactory condition occurring, during, or subsequent to production acceptance testing.
- Failure or unsatisfactory condition which occurs prior to acceptance testing that will affect or has the potential of adversely affecting safety, will contribute to schedule impact or launch delay, or will result in the need for design change, or indicates a generic EEE parts concern (trend).

PROBLEM ANALYSIS - A documented investigation performed to determine the cause of a problem.

PROBLEM CAUSE - The event or series of events directly responsible for a problem.

PROBLEM, CLOSED - A problem is closed when the hardware and software supplier is formally notified by the responsible NASA Center or International Partner of their concurrence in the problem analysis (including determination of the cause) and has implemented corrective action to preclude recurrence of the problem.

PROBLEM, EXPLAINED - A problem is explained when the originator is formally notified of the responsible NASA Center or International Partner concurrence in the problem analysis and rationale for not establishing corrective action. The rationale must establish that a planned mission may proceed with no detrimental effects should the problem recur and that the responsible NASA or International Partner authority has decided that no corrective action (as for a closed problem) need be taken.

PROBLEM REPORTING AND CORRECTIVE ACTION - A controlled technique for identifying, reporting, analyzing, explaining, and preventing recurrence of problems.

PROCESS CERTIFICATION - The process of assuring the capability of personnel and/or acceptability of equipment/materials/procedures prior to performance of operations affecting product quality.

PROCUREMENT DOCUMENTS - Such documents as purchase orders, subcontracts, statements of work, technical specifications, and inter-corporate work orders required to define articles, materials, and services being procured and the terms and conditions imposed.

PRODUCT ASSURANCE - A function that includes the Reliability, Maintainability, and Quality Assurance, disciplines.

QUALIFICATION TESTS - Tests conducted as part of the certification program to demonstrate that design and performance requirements can be realized under specified conditions.

RECURRENCE CONTROL - Action taken to prevent repetition of a nonconformance.

REDUNDANCY - The existence of more than one means for performing a given function.

RELIABILITY - A characteristic of a system or an element thereof expressed as a probability that it will perform its required functions under defined conditions at designated times for specified operating periods.

REMEDIAL ACTION - Action to correct a nonconformance.

REPAIR - Operations performed on a nonconforming article or material to place it in a usable and acceptable condition; requires additional written procedures and additional operations.

RESTORABLE - The ability to reinstate specified operating conditions in an item by appropriate maintenance action.

RISK - The chance (qualitative) of loss of personnel, loss of system or damage to, or loss of equipment or property.

SAFETY - Freedom from chance of injury or loss of personnel, equipment, or property.

SAFETY ANALYSIS - The techniques used to systematically evaluate and resolve hazards.

SAFETY CRITICAL - Any condition, event, operation, process, equipment, or system with a potential for personnel injury or fatality, damage to or loss of equipment or property.

SINGLE FAILURE POINT - A single item of hardware the failure of which could lead directly to loss of life, ISS Elements, or critical mission support capability.

SOFTWARE - Machine instructions, including firmware, in the form of codes, data, and associated documentation.

SYSTEM SAFETY - The optimum degree of risk management within the constraints of operational effectiveness, time, and cost attained through the application of management and engineering principles throughout all phases of a program.

VERIFICATION - A process which determines that the ISS hardware and software systems meet all design, performance, and safety requirements. The verification process includes analysis, test, inspection, demonstration, or a combination thereof.

WAIVER - A written authorization, granted after the fact, for use or acceptance of an article which does not meet specified